Engineering Record

A Weekly Journal Devoted to Civil Engineering and Contracting

PUBLISHED BY MCGRAW PUBLISHING COMPANY, INC.

Volume 70 NEW YORK, SATURDAY, JULY 11, 1914 Number 2

Chicago's Building Height Limit

CHICAGO is to be congratulated on the action of her City Council in refusing to pass an exception to the 200-ft. building-height limit in favor of property owners who desire to erect a hotel with a cornice height of 260 ft. There is all the more reason for congratulation because the influence brought to bear was unusually powerful. Some of the influential newspapers, the mayor and the building commissioner favored the exception. That the erroneous impression prevails that a city's greatness is measured by its building monstrosities is evidenced by an editorial in the Chicago "Herald." "The swaddling bands in the present ordinance restricting the heights of structures," it says, "have no place in the modern scheme of city development." Evidently the "Herald" has no conception of the strides made in recent years in city planning. Its essence is to reduce congestion by keeping down height limits, widening thoroughfares and creating direct routes between different sections of the city. So long as newspapers which are expected to be leaders in civic thought think along lines of a by-gone age so long will difficulty be experienced in insuring proper civic development.

Outlet Valves for Dams

ENDURANCE tests of parts of large valves are so unusual that hydraulic engineers will be interested in the account on page 53 of the valves for the Arrowrock Dam. The design is not new, since similar valves have been used at the Roosevelt Dam since March, 1911. Before deciding on their application at Arrowrock, however, an endurance test, representing fifty years of actual service, was made on certain parts. The results, as given in the article, indicate that the life of the valves is unusually long and practically indeterminate. One other matter is suggested by this article. It will be noted that the valves have been placed on the face of the dam, so that they are inaccessible except when the pond is drained. While undoubtedly the special conditions at Arrowrock were taken into consideration in adopting this design, its use generally is open to question, for, as a rule, impounded lakes cannot be drained without serious inconvenience. The valves ordinarily had better be placed in chambers or recesses within the masonry so that they can be closed by temporary stoplogs or gates and thus made accessible. The endurance tests apply only to the normal operation of the valves. There is no guarantee, however, that water-soaked logs or trash will not get into the openings and prevent the valves from closing. As the velocity of approach of the water is high, such an obstruction might even break parts of the valve or interfere with its alignment. Screened recesses eliminate these dangers and, in addition, make the gates accessible under all conditions.

Specifications and Co-operation

PROFESSOR TALBOT performed a real service to the profession in pointing out in his presidential address before the American Society for Testing Materials the opportunities for research and co-operation in the preparation of specifications. While both have been put to service with more or less frequency it is necessary occasionally to take time for a survey of past accomplishments. Then only does the real progress of the immediate past show itself clearly. In a general way we have been aware in recent years that a considerable amount of co-operative work was being done between societies, and we have also known that the research laboratories, both public and private, have been called into requisition in securing information upon which specifications were to be predicated. It is doubtful, however, whether anyone, except one who has been in close touch with both of these agencies, appreciates how extensive their activity has been. Professor Talbot has made clear the extent to which they have been called into service and thereon builds an argument for more extensive research and for more active co-operation in the future.

Specifications and Research

THE necessity for technical research becomes more and more apparent as the work of any one committee of the American Society for Testing Materials proceeds from a specification as to general requirements to one of detail. Then only is the lack of full data appreciated and then only is a committee able to map out a proper research program. Probably most of the committees of the society have reached the stage—some of them years ago—when they can formulate satisfactory programs. The relations which have been established by these committees with the Bureau of Standards, the engineering experiment stations and the laboratories of the engineering colleges presages a large amount of invaluable research work in the near future. Such co-operative work is sure to produce results of practical value because of the experience of the committee members who outline the programs and direct the work. Certainly the colleges ought to enter into such cooperation with much enthusiasm, for they will thereby secure the advice of those best qualified in the various specialties. As to co-operative work between societies no urging is necessary. They are alive to the need of the widest discussion of proposed specifications by those qualified to speak. Therefore are there joint committees almost without number at the present time. It is significant that the American Society for Testing Materials and the American Railway Engineering Association are invariably represented on such joint committees—a tribute to the personnel and efficiency of these organizations. Their work already embodies much for which Professor Talbot pleaded in his address.

The Influence of Position

THE influence which a man who is in the public eye can have on an important problem has been strikingly shown in New York recently. Thinking citizens and students of New York's educational system have long known that the results, so far as disseminating education broadly has been concerned, are lamentable. Out of 86,000 children who annually enter the lowest grade of the grammar schools only 4000 eventually are graduated from the high schools. This is an appalling mortality. Of those who enter, only 48,000 complete the grammar school course and only 23,000 actually enter high school. The great loss, therefore, is not in the high school itself, but between the lowest grades of grammar and secondary schools. This fact has been pointed out several times in this journal. If those who do not reach high school had a proper industrial preparation the condition would not be so serious, but experience shows that they are ill-fitted to enter industrial or business life and must be content, unless exceptionally gifted or unusually ambitious, with the lower positions in the struggle for a livelihood. Mayor Mitchel, who has recently been studying the situation, has been impressed by it, and is determined that something shall be done to give these children an equipment which will help to divert them from the ranks of the incompetent. The demonstrations of unrest in New York have probably brought to the Mayor's mind that the children improperly educated are sure to swell the ranks of discontent. The effect of the Mayor's interest has been an awakening on the part of prominent citizens to the city's responsibility and to its opportunity. As a result there is reason to believe that before long some sort of vocational and continuation school work, properly correlated with industry, will be undertaken in the nation's metropolis. For this great step the Mayor individually will be largely responsible, for it is through his interest that the city has been awakened from its educational apathy.

Licensing of Operators of Water and Sewage Treatment Plants

LICENSING attendants at sewage treatment plants in New Jersey is the suggestion made by Francis E. Daniels, director of the water and sewerage inspection division of the State Board of Health, in his recently published annual report for the fiscal year ended Oct. 31, 1913. With this recommendation sanitary engineers will heartily concur, for if a license were necessary it would prevent much of the trouble at plants which are now operated by attendants absolutely ignorant of the fundamental principles of sewage treatment. It is fair to infer that the recommendation is intended to cover also the supervision of water purification works.

Of course, the plea for skilled supervision over plants for the treatment of water and sewage is an old one, but the matter is of such vital importance to the welfare of a community that it can bear frequent repetition. It seems hard to convince the makers of laws that any laborer or mechanic is not qualified to control the operation of sanitary works, although the necessity for a licensed engine runner to take charge of a steam boiler plant is generally conceded. When a boiler explodes, wrecks a building and kills its occupants, the relation of cause and effect is made apparent in a most spectacular way. It makes a good "story" from the viewpoint of the newspaperman and consequently the public hears of it and insists upon protection. But when people drink polluted water and die of typhoid a week or two later, no one seems to attach blame to the ignorant filter attendant who suspended the sterilization of the water while he cleaned out his hypochlorite tanks or by-passed raw water around his filters because his sand beds became clogged.

The need of intelligent attendants is particularly necessary in plants fitted with complicated dosing or alternating devices. Such arrangements, at best, require the attention of a careful and capable man, and much of the trouble in the field is due either to the improper construction of the dosing device or to the fact that the attendant fails to understand or comprehend the mechanical contrivances and their operation. Too much reliance should not be placed on these automatic alternating and dosing devices, for they get out of order, and when out of order usually require the attention of someone thoroughly familiar with their construction and operation.

Here, again, is an opportunity for engineers and engineering societies to do valuable educational work. There has been too much lamenting about the disgraceful inefficiency in the operation of filters and sewage treatment plants and too little constructive work to improve it. It is time for technically trained men, who realize the dangers of the present lax methods, to secure legislation which will take out of the hands of the unskilled workman or the political appointee the control of sanitary works upon which the health of an entire community depends and which should be supervised by a skilled chemist or sanitary engineer. It is also time for city councils to loosen the municipal purse strings to the extent of providing an adequate salary for a competent operator or, if the town be a small one, to arrange with other communities for a central laboratory and joint supervision of their filters or sewage plants by properly qualified men.

Danger of Undermining Subway Excavations

ONE naturally asks whether the disastrous street accidents in Paris, described both in this and in the last issue of the Engineering Record, are likely to occur in subway construction on this side of the water. In other words are there lessons to be learned from the Paris experience which are directly applicable to work in hand in this country?

The Paris trouble was due to the failure of sewers under severe and abnormal conditions and to the effect on temporary work rather than to any failure of completed structures under permanent conditions. The case thus becomes primarily one of construction methods and conditions, and, secondarily, of consideration of the provisions requisite in permanent structures for possible temporary emergencies varying greatly from working conditions. Both aspects apparently are pertinent to a large amount of construction and excavation work, and especially where subway construction is in progress.

The Paris subway, located in sandy, wet ground and treacherous fill, is a double-track masonry arch structure built in longitudinal tunnel headings, commencing at the crown and extending transversely on both sides to the skewbacks. In them the arch is constructed before the side walls, the whole being supported on timbering until the completion of the invert, thus leaving a somewhat unstable structure in a large excavation for a considerable time. Large sewers and other structures were intersected and exposed, their original supports removed, and their weight carried on shoring, bracing and temporary supports. The heavy rainstorms developed pressure in the sewers, already weakened by removing outside supports, and their bursting flooded the excavation, undermined the shoring and temporary supports, and caused the collapse of the finished and unfinished structures and of the thin earth roof above, which supported the street.

To guard against future accidents of like nature the precautions are obviously to support and reinforce the sewers beyond any possibility of destruction as soon as they are threatened by excavations alongside; to leave sections of the new structure uncompleted or unsupported for only the briefest feasible period; to provide complete support for the street surface when the earth roof below it is shallow, and finally to exercise constant rigid inspection of the work. These restrictions might prohibit the method of construction used in Paris, without reference to the type of finished structure. It might also be worth while considering whether or not excess strength is justified in permanent structures as a provision for possible emergencies of this sort.

Accidents like that in Paris are not likely to occur in American subway work because nearly all of the construction in heavy traffic streets, although in treacherous material near the surface, is made by the covered-trench method, where the street is fully supported by a heavy steel or timber roadway platform having its supports carried below the danger of scour or undermining. Compared with this procedure the Paris method is far more likely to give trouble. Moreover, exceptional care is exercised in the temporary support and bracing of sewers, water mains and other structures encountered, while the inspection is rigid and continuous. Many of the larger and more important of these structures are by-passed, replaced, or put out of service while the subway construction adjacent to them is in progress. As a result no serious accident has yet occurred here from their breaking. The almost universal type of steel-frame construction for American subways enables them to be built in complete transverse sections and they have, therefore, much greater stability against undermining, settlement, and collapse during construction than has the Paris type.

Status of American Society for Testing Materials

NO one could attend the meeting of the American Society for Testing Materials last week without recognizing in the society an efficient, virile organization. So calmly did the meetings proceed that some characterized it as a "tame" convention. And so it was, if the absence of excitement from the floor of the convention be taken as a criterion. But behind the scenes the meeting was far from tame—indeed, it was exceedingly strenuous. Committees were in constant session from Monday night till Friday morning, their meetings overlapping the general sessions and extending far into the night. The tameness on the floor was evidence that the committee work had been well done, and it is not far from right to say that the efficiency of the organization as a whole is inversely proportional to the absence of friction in the general sessions.

The character of the meetings has changed much in recent years. Formerly producers and consumers, unable to compose their differences in committee, fought them out in open meeting. The wordy encounters were frequently sharp. Those incidents were the accompaniments of primary education. The two sides were factions—producer against consumer—and had not yet become fully convinced that their interests were mutual. But progress has been made. The adversaries, having learned through logic and by measuring their opponents' strength, have ceased to be adversaries, and, while, necessarily, there will always be partisan interests, the committees have learned that their respective industries are better served by compromise and agreement in committee than by airing grievances before the general meeting. There is no doubt, however, that wide breaches occur but seldom, as compared to the experiences some years ago. Controversy now is generally concerned with details. It would be millennial to find no divergence in views between producers and non-producers. Moreover, full accord would not be as beneficial to the industries as might seem, for only by strenuous and honest support of opposing views is the real truth brought out.

Appreciation of the work of the society, however, should not allow one to be blinded to the fact that some of the committees have information that is being suppressed which would be of much value to the consumer. True, it would reflect adversely on the product of some manufacturers; and while it may be contended that data and materials given freely for scientific purposes should not be used against the donors, the very object of the society's existence—to draw up specifications under which satisfactory materials may be purchased—demands that information should be published as to products which have proved failures. Data of this kind have been given out, but much is still kept back.

It might be well to question, also, whether the society's interests might not be better served by giving publicity to the lines along which the committees are working. That may, it is true, bring protest from every crank who has a theory on the subjects under discussion or an interest that will be affected. The other view, however, is that all worth-while advice should be welcomed by the committees. It is likely, too, that interest in the society would be the greater if more details were published as to the activities of the committees. If, for example, the wide scope of the studies of the new committee on concrete aggregates were generally known it cannot be doubted that the interests of concrete workers in the society would be stimulated.

That the society's work is more and more appreciated every year is evidenced by the steady increase in membership and in attendance at the annual meetings. The membership is now 1687, while the registration of men last week reached 490, as against 360 last year. Needless to say, the society well deserves the support it is receiving. It is a most important factor in the engineering life of the country—how important no one can estimate, for its work affects, from coast to coast, not only the cost of structures but also the safety of those who use them. Mindful of its opportunities, too, the society is rapidly pushing its work into new fields. Engineers can, therefore, look with confidence to an even greater influence for the society in the near future than it enjoys to-day—and even now it stands in the forefront of our technical organizations.

Testing Concrete Aggregates—A Plea for a Rational Method

CONCRETE has been used as a material of construction for more than 2000 years, yet like other engineering materials specifications and methods of test to differentiate it are of recent origin. Moreover, specifications and tests have been developed only for the cement, and even they are imperfect and in some respects misleading. The fine and coarse aggregates and the finished product still lack the dignity which attaches to a material of which it may be said that "it conforms to specifications." Why this is so it would be difficult to explain. Possibly familiarity with common sand and stone has bred a contempt for them. Having been led into many serious difficulties, and having sustained financial losses in some cases through failure to consider properly the quality of the fine and coarse aggregates, there has now been awakened an interest in these matters which may in time produce the much needed standard specifications for these materials. One society, the American Concrete Institute, has had a committee at work on the subject for two years, and another society, the American Society for Testing Materials, has recently appointed a committee to take up the subject. These two bodies should, and undoubtedly will, work together, but the ground is comparatively new, and a great deal of underbrush will have to be cleared away before much progress can be made on the main problem.

From time to time articles on the testing of sand and aggregate have been published in this journal, but as no concerted or systematic action has been taken by bodies whose recommendation would be accepted, we are still without any method of test which may be called "standard."

In view of the present unsettled state as regards these matters and of the present prospect of securing co-operation between the committees named, it may not be amiss to discuss some of the points to be considered in drawing up a standard specification for aggregates, fine and coarse, and in devising the proper methods for testing them.

The matter of methods of test is of first importance. They must be standardized before specifications can be drawn. It is useless to specify the qualities that a material must possess, or the extent to which it must possess them, without deciding first on the manner of measurement. At present it is not unusual to see a specification which states that the sand "shall be clean, sharp, silicious material, free from loam or other deleterious matter." That is a good specification, except that many first class sands would fail to pass on every count. Few sands are perfectly "clean," while a rounded sand is better than a sharp one, if by "sharp" is meant "angular" or "having sharp edges." Some almost non-silicious sands are better than some almost purely silicious. A little loam or extremely fine material is often beneficial, and lastly—what matters are deleterious? The whole specification reminds one of the weather-beaten story of the student in natural history who, when asked to describe a lobster, said that "it is a red fish which goes backward." "Right," said the professor, "except that it is not red, is not a fish, and does not go backward."

Concrete aggregates are often tested in the laboratory for such qualities as tensile and compressive strength, percentage of voids, granulometric analysis, weight per cubic foot, specific gravity, increase in volume of mortar mixtures, etc., to the number of about twenty, when really there are only two or three qualities which they are called upon to possess in practice; namely, that when mixed with Portland cement in the proper proportion the resulting mixture shall have the required compressive strength, or impermeability or resistance to wear.

The qualities to be determined in the laboratory and those required in actual service should be either identical or so related that one may be derived from the other. For instance, if a definite relation existed between the tensile and compressive strengths of mortars, it might be admissible to make the simpler and easier tensile test in the laboratory and interpret the results in terms of compressive strength. But unfortunately no such definite relation exists, and if we want to know the compressive strength of a concrete or mortar we must test it in compression. Why not begin with the compression test and get directly the information desired? Or, if the concrete or mortar is to be used as a wearing surface, why not begin, and perhaps end, our tests with a determination of the quality it is essential that the material possess? The same applies to permeability.

When an engineer is called upon to decide which of several available concrete materials shall be used on a particular job for a particular purpose he must first decide which of the materials will produce most economically a concrete possessing the desired qualities in the required degree. Such a decision involves the proportion of the mixture, and there appears to be no way at present to secure the data necessary for the passing of safe judgment without actual test for the particular quality in question. A knowledge of the percentage of voids or of some other quality in an aggregate may be interesting, and sometimes important, but it does not always tell the engineer in what proportions to mix his concrete in order to get a compressive strength of, say, 3000 lb. per square inch in 28 days or an absorption of 5 per cent or less at an equal period or a wearing surface suitable for a power house or factory floor. Just what the chances for error are can be appreciated by a reading of the discussion on the proportioning of aggregates, which appears elsewhere in this issue.

It is to be hoped that as a result of the present widespread interest a method of testing aggregates will be developed which is more rational and direct than is our present method of testing Portland cement.

Siphon Tunnel under Lake Washington Canal

Bore Through Caving Ground in Seattle Contains Sewer Pipes, Conduits for Light and Power Wires and Gas and Water Mains

In the construction of the north trunk sewer at Seattle, Wash. (see Engineering Record of Feb. 14, page 194), it was necessary to provide means for passing an ultimate sewage flow of 20,000 cu. ft. per minute across the Lake Washington Canal, which is now in process of construction. After some study of conditions it was decided to sink vertical shafts on either bank of the canal and connect these by a tunnel in which the pipe of an inverted siphon could be placed. It was also decided that the shafts and tunnel should be made large enough to accommodate, besides sewer pipes, conduits for light and power wires, as well as gas and water mains, and that each of the several departments represented should contribute something toward construction and maintenance costs.

As finally worked out, the joint plan binds the water department to pay $30,000 toward the total cost of the improvement and fixes an annual rental which will be collected from the other departments using the tunnel. Construction was carried on by the city during the time that the north trunk sewer was being built. Since the combined sewage system is used in this part of the city, it is thought that future development has been sufficiently provided for by computing the sewer capacity on the basis of the area drained. The maximum hourly rainfall was taken as ½ in., and one-half this was taken as the maximum hourly runoff, or 15 cu. ft. per minute per acre.

Sinking Shafts

The route surveyed for the sewer intersects the Lake Washington Canal at a point about 20,000 ft. from the outfall, and, accordingly, at this point a site was selected on the south bank of the canal for the location of the gate house which stands directly over the south shaft. The siphon is built at right angles to the center line of the canal, which is 300 ft. wide and has a normal depth of 55 ft. below street grade. On each bank a rectangular shaft with inside dimensions of 12 x 15 ft. was sunk to a depth of 80 ft. The material encountered first was dry sand, but at a depth of 30 ft. this began to contain water, which increased in quantity in the next 30 ft. At a depth of 60 ft. a 10-ft. layer of mixed sand and gravel was found, and below this the shafts were sunk through 10 ft. of hardpan. The material just above the hardpan carried great quantities of water and was very difficult to handle, the pumps delivering at times as high as 500 gal. per minute.

The north shaft was driven by the use of a 3 x 12-in. tongued and grooved lagging in 14-ft. lengths, the seepage being handled by two 4-in. electrically driven centrifugal pumps. In the south shaft, however, the pressure became so great that this method was not feasible for completing the work. A cutting edge was, therefore, constructed, which consisted essentially of a ½-in. steel plate bolted to a rectangular frame of 30 x 16-in. timbers and skirted by a sliding shield of 4 x 8-in. timbers. This structure very much resembled an open caisson without full-height walls.

Thus the cutting edge was forced down by jackscrews, and as it descended 3 x 12-in. planks were inserted and spiked to timber bracing. This method proved satisfactory, and the rate of progress averaged 1 ft. of timbered shaft completed for each day of its use. As soon as the desired depth had been reached the shaft was concreted, beginning with a wall thickness of 27 in. at the bottom and decreasing to 18 in. at the top. The reinforcing was 1-in. corrugated bars placed horizontally in each wall, 2 in. from the inner surface and set 4 to 12 in. center to center. Cross-bracing was provided by a pair of 12-in. I-beams placed at right angles every 10 ft. vertically.

Driving the Tunnel

The 313-ft. tunnel which connects the two shafts is 14 ft. wide and 11 ft. 6 in. high at the crown of the arch. Its floor at the north end is 60.25 ft. below water level, whence it slopes on a grade of 0.76 per cent toward a sump under the south shaft. Plain concrete 24 in. thick was used for the floor and arch, while 36 in. is the thickness of the walls, inclusive of the wooden timbers which stand behind the concrete. Every 12 ft. a 9-in. steel I-beam was placed horizontally across the tunnel 7 ft. above the floor to provide a support for the two 16-in. gas and two 60-in. water mains.

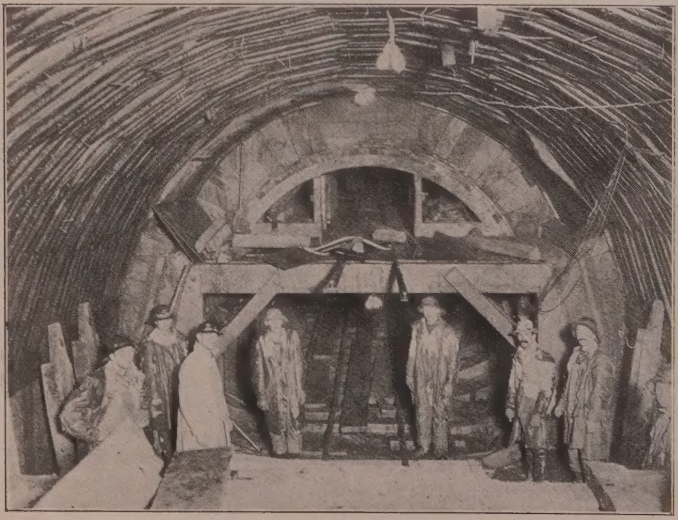
The method of driving the tunnel was worked out in the endeavor to protect the work as much as possible from the excessive seepage. It was only by making both timbering and bracing very strong that progress was possible, because the overlying material was not to be depended upon; in fact, it frequently caved in, despite precautions. On several occasions the break loosened the material all the way to the bed of the canal and caused a flow of water which made a good deal of trouble and delay in the tunnel. During the construction a battery of 4-in. electrically driven centrifugal pumps was kept on the job, and was often worked to capacity. The average rate of progress was 2 ft. of completed tunnel per day.

Features of Design

The total amount of sewage which may be handled ultimately at this point in the north trunk sewer was estimated at 20,000 cu. ft. per minute. Therefore the inverted siphon for which the tunnel was designed is to consist of two steel pipes 60 in. in diameter, each calculated to carry 10,000 cu. ft. per minute. In computing the fall necessary to secure perfect operation the length of the siphon was taken as 470 ft., the diameter 60 in. and the discharge 10,000 cu. ft. per minute with a velocity of 8.5 ft. per second.

Using these values and substituting respectively in Merriman's formulas for friction, entrance and head, the equalities $f' = 0.011$, $f'' = 0.5$ and $f''' = 0.184$ for the 4-ft. radius and 0.047 for the 8-ft. radius. The total lost head due to these three causes was computed as 2.38 ft. The siphon was built with a fall of 2.51 ft. This head was made more effective by constructing the entrance and discharge tubes so as to reduce friction where square and round conduits join.

The two 60-in. pipes shown on the drawing represent the arrangement for ultimate


TIMBERING IN THE SOUTH SHAFT

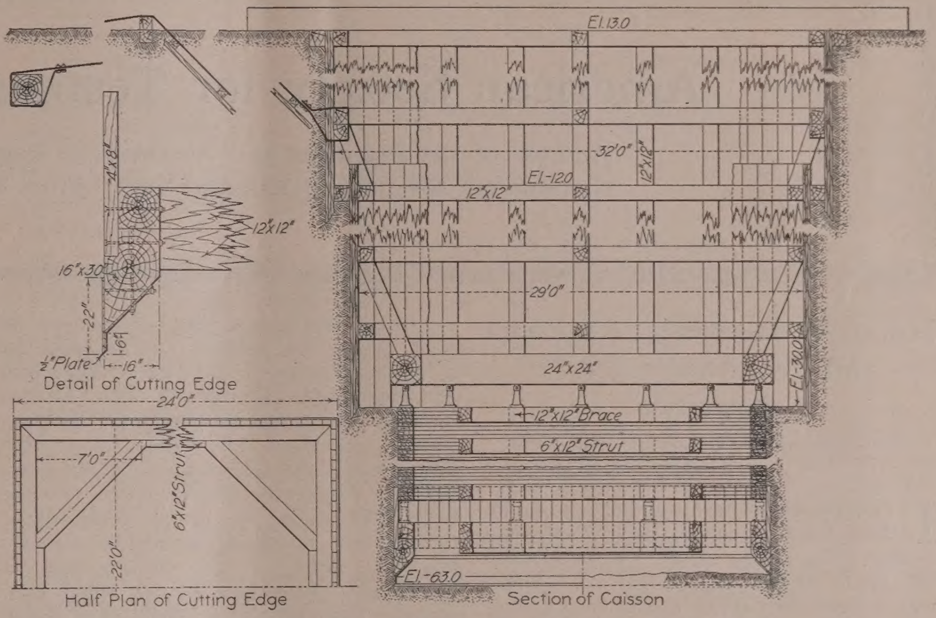
48-INCH PIPE IN SIPHON TUNNEL

capacity, while in the illustration of the tunnel interior a single 48-in. cast-iron pipe is shown. The latter has been temporarily installed as giving ample capacity for the sewage flow for some time to come, and has the advantage of giving a higher velocity for the small flow than would be obtainable in the 60-in. pipes.

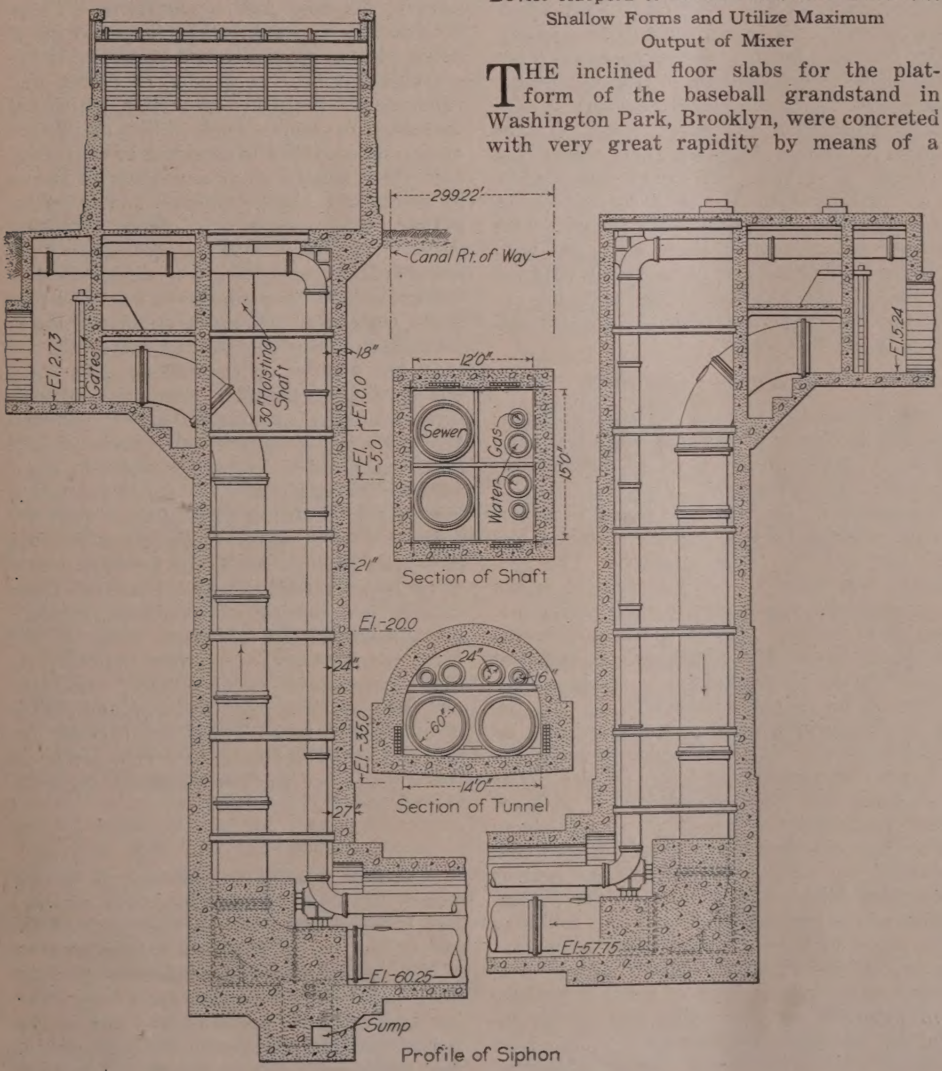
The approach to the siphon is made by a 9-deg. curve, involving a diverging section. Gates are placed across the entrance and also at the discharge to allow for closing and cleaning either of the 60-in. pipes. A converging section drains the siphon into the sewer beyond. The interior of the siphon pipes was given a coating of cement mortar to protect the steel from erosion caused by the acid action of the sewage.

The shaft house, which is located over the lower end of the siphon, is 19 x 26 ft. in plan and contains, besides gate valves and connections, an automatically starting centrifugal pump with motor and switches, which is to remove seepage from the sump; it will also aid in cleaning, if this should be necessary. Since the siphon was put in use, on June 1, 1913, its operation is said to have been perfectly satisfactory under large and small heads, and seepage through the tunnel walls has been very slight. It is considered expedient, however, to pump out the sump once a day.

The siphon tunnel and inverted sewer siphon were designed and built under the direction of A. H. Dimock, city engineer, by A. L. Ferver, superintendent of sewer outfalls. L. H. Larsen was general foreman. The total cost was about $175,000, of which $10,000 was applied on the cost of equipment used in the work. About eighteen months were required to complete excavation and place all concrete.



CONSTRUCTION ARRANGEMENT FOR SINKING SOUTH SHAFT



FEATURES OF SEATTLE UTILITIES SIPHON

Chuting Concrete Through Intermediate Hoppers

Device Adopted to Reduce Flow of Concrete into Shallow Forms and Utilize Maximum Output of Mixer

THE inclined floor slabs for the platform of the baseball grandstand in Washington Park, Brooklyn, were concreted with very great rapidity by means of a system of main and auxiliary chutes and intermediate distributing hoppers. The V-shaped platform, 119 ft. wide and 852½ ft. long on the outside, is inclined about 1:4, with the upper surface offset to form 8-in. risers and 33-in. horizontal treads, reinforced top and bottom, as described in the Engineering Record of June 20, page 702. The concrete was delivered from three chuting towers 86 ft. high with Wylie chutes 96 ft. long, inclined at a slope of about 1:4. As each chute delivered at the rate of about 150 yd. in eight hours, it was realized that an attempt to distribute such a large volume of concrete from a single point at the extremity of the chute would be practically impossible and the forms would be overflowed if not wrecked.

In order to maintain the maximum tower discharge and serve wide areas of floor construction advantageously, the tower chutes were made to discharge into auxiliary 5-yd. hoppers located 150 ft. apart on the horizontal platform extending the full length of the grandstand. Each hopper was provided with five chutes made up of one, two or three 12-ft. lengths of 6 x 16-in. steel coal chutes supported on horses and delivering separate about 3¾ yd. per hour of concrete to different portions of the floor slabs, where it was hoed down to required position at maximum distances 15 ft. to 20 ft. from the ends of the chutes.

The distributing hoppers were also provided with gates through which a small amount of concrete was delivered to Ransome cars for filling column and strut forms. The distributing hoppers thus served very efficiently as reducing valves for the main flow of concrete and were important factors in enabling the work to be carried on rapidly and satisfactorily. Without this method of extending and controlling the distribution of the concrete the P. J. Carlin Construction Company, the contractor, believed that very much slower and less satisfactory progress would have been made.

SEWAGE-TREATMENT PLANTS in operation in New Jersey on Oct. 31, 1913, the end of the fiscal year, numbered 130, according to the annual report of Francis E. Daniels, director of the water and sewage division of the State Board of Health.

American Society for Testing Materials

Address of the President and Abstracts of Papers Read at
the Annual Meeting in Atlantic City, June 30 to July 3

Relation Between Research and Technical Society Activities

Extracts from the Presidential Address of
A. N. Talbot

IT is unnecessary in this audience to establish the need for definite, trustworthy and complete knowledge of the properties and actions of engineering materials. There was a time when general information, common belief, or even say-so opinion was all that was available for outlining specifications upon which material was to be purchased. Since the formation of the society great advance has been made in our real knowledge of materials, very much of it being due to the activities of the society itself, and we are now where the value of the fruit of research is appreciated. As soon as the surface is scratched over the need of systematic investigation becomes apparent. Ultimate progress involves a searching, critical and thorough inquiry and investigation into the facts and principles relating to the subject. More and more as time goes on will the society need to avail itself of the fruits of research.

Fortunately for us, the agencies for gathering knowledge and for conducting research are many and varied, and their number and opportunities are increasing. First in time, and in the past perhaps first in opportunity, may be named the producer or manufacturer. Next to the producer may be mentioned the consumer, whose interests in research should be as large as, or larger than, the producer's, though neither of these agencies has always realized its investigational opportunities and responsibilities. The private laboratory of the consulting engineer, testing engineer, or chemist and the independent research institute constitute another agency. The various Government laboratories, the engineering experiment stations and the laboratories of engineering colleges and technological schools may be grouped together as still another agency. The list would not be complete without including an agency which has been especially productive in effective investigational work in the past few years, and which may be expected to render still more valuable service in the future—I refer to co-operative work by scientific and engineering societies and their committees in connection with producer, consumer, scientific laboratories and individuals.

RESEARCH BY PRODUCERS

There was a time when the knowledge of the properties of certain engineering materials emanated principally from the producer, or was even held by him as trade secrets. The manufacturer has special opportunities for learning the qualities of his output—in certain directions at least. He needs to know something of its properties, for during the initial stage of business he must develop his product, and generally he must work to develop its field of usefulness and applicability in order that his business may grow to proper proportions. Competition compels him to know about his product and perhaps about the product of his competitor. There was a tendency then to withhold information; the brand of the established house was held sufficient as a specification. Time has thrown purchase by brand into disuse except for small purchases. The brand of a cement or of boiler plate still has selling value, but the producer must contract to deliver an article which will comply with definite specifications. Buying by specification is considered to be of great advantage to the consumer, for it permits of intelligent competition and gives an agreed statement of what properties are wanted, and is it not therefore advantageous to the producer also?

Granting purchase by specification, knowledge of the properties of a material is of great importance to the producer. And the producer is in a position to learn about his product. He is on the job continually. His chemist and his testing engineer keep tab on the work, and these trained and experienced men are able and willing to conduct researches to learn more of the material and of its action under varied conditions of service. A large amount of valuable investigation has been carried on by the producer. May we not expect with proper recognition of their work and with proper suggestion and co-operation that the fruits of the producer's research laboratories may multiply greatly in amount and in value to the public?

RESEARCH BY CONSUMERS

The consumer is in a different position; he has to live with the material; he knows how it works, how it wears, whether it breaks and what the disastrous consequences are. He comes to think he knows what qualities he wants in the material, and he may ask for these qualities. The producer may have to tell him that it is not commercially practicable to make such a material, or he may insist that the cost would be prohibitive. The consumer may find that it will be to his advantage or to the advantage of his client, the public, to use the better material even at an increased cost, as in the case of the rail which reduces the chance for accident and loss of life. The consumer has many opportunities to learn the peculiarities of a material or a product; and the intelligent systematic record and analysis of failures or defects, of service and durability, add greatly to our knowledge of the properties of materials and may be made to form an even more important source of information. The laboratories of the consumer have been of great assistance in determining properties and in formulating adequate requirements. But here again, with an increasing number of laboratories and with increased interest on the part of the consumer in the work of their laboratories, may we not expect, as the years go on, that the contributions to knowledge from these laboratories will increase manyfold?

The next group, the private research laboratory, may at times serve the producer and at other times the consumer, in which cases it may be classified with the producer's and the consumers' laboratories; or it may serve as an independent research laboratory to investigate and report independently upon a research problem which is of common interest. This agency is also increasing in usefulness and we may expect its influence to grow with the years.

GOVERNMENT AND COLLEGE LABORATORIES

Government and college laboratories occupy an independent position. They enjoy the very full confidence of the public who feel that these laboratories are not connected with special interests and that research problems will be handled with judicial fairness and impartiality. These laboratories enjoy the further privilege of being able to devote time and money in researches into the principles of action and fundamental nature of materials, which are seemingly of remote applicability and do not appeal directly to the producer or consumer, but which finally, after a number of pieces of work have been completed and fitted together, may prove of intense practical value. The expansion of the Bureau of Standards in recent years is an instance of the growth of Government testing and presages something of future opportunities in investigations in engineering materials.

In the field of college laboratories there has been a development that may surprise those who have not kept informed. At least six engineering experiment stations have been organized in connection with the engineering departments of state universities. Research laboratories of similar purpose are connected with other engineering schools. Still other schools are doing investigational work in an informal way. From all these sources are coming contributions to engineering knowledge of great value in the form of bulletins and other papers. As these laboratories become better organized and their staffs acquire training and skill is it not to be expected that this agency for research will become a powerful factor in the widening of our knowledge of engineering materials?

CO-OPERATIVE WORK

And now I come to the last of the research agencies to be named, one which I feel is most important in the work of the society and one on which the future progress of the society greatly depends—co-operative work between the committees of engineering and scientific societies and the laboratories, facilities and store of information of the producer, consumer and independent laboratory. This form of activity takes advantage of the knowledge and experience of the man who is familiar with the processes of manufacturing and their peculiarities and limitations; of the man who knows the needs and the shortcomings of the articles in use; and of the unattached expert who may be able to help to correlate the views and interests of the other two. It gives breadth and depth to the scope of the inquiry and purpose to the method of testing. It assists in the analysis of data and the formulation of conclusions, and may aid in making the action of the society more readily acceptable to all interests concerned. Doubtless, however, the element of patience may need to be developed in such an organization.

You are all familiar with this form of activity in this society and in other societies, and I need only refer to a few instances to bring to your mind the results which this agency has already accomplished. A case at hand is the report of Committee C-6 to be presented at this meeting, a very valuable piece of co-operative work on the methods of testing and on the available strength of both clay tile and concrete tile, made possible through the facilities of the engineering experiment station of the Iowa State College. Committee C-3 has now available valuable data on the strength of the building brick that are now in use in various parts of the country, secured through co-operation with college laboratories, and the same committee has recommended a standard method of testing paving brick based on a somewhat similar form of co-operation. The work of the committees on iron and steel and on preservative coatings furnishes many similar examples. The report of the committee on concrete and reinforced concrete, which brought order out of chaos, was based on co-operative research work.

Other societies are using the co-operative agencies. Several recent reports of committees of the American Concrete Institute include valuable research material obtained in this way. The American Railway Engineering Association has utilized this agency extensively, though its most important research, that on rail, which is destined to put rail purchase and rail use on a new basis, has been carried on almost independently. In the work of the committees of the American Society of Civil Engineers the extensive tests of steel columns now being carried out form an interesting example of co-operative work. Perhaps the recently constituted joint committee of the two societies last named formed to investigate the stresses in railroad track—rail, fastenings, ties, ballast and roadbed—will prove to be the most extensive piece of co-operative work yet undertaken.

I have named these examples of co-operative work to freshen your memory and to suggest the possibilities of this form of research. I want now to advocate the extension of its use as an activity of the society and to urge upon our committees the value of co-operative research work. It seems to me that members may well encourage the making of larger appropriations for National, State and semi-public laboratories, and may properly ask manufacturers and consumers to support liberally research in all lines touching on engineering materials. The initiative for this co-operative work and its direction may well be left to the committees of the society, whose members are so intimately interested in their work. Possibly some day there may need to be a general research committee of the society to co-ordinate work and to stimulate opportunities. What is wanted now is a fuller understanding by the committees of their needs and opportunities and a formulation and direction of the problems before them. Make co-operative research work a feature of the society and the fruits will be visible everywhere.

Proportioning Aggregates for Concrete

Discussion of Maximum Density vs. Compression Test Method for Determining the Suitability of Sand, Broken Stone and Gravel

By ALBERT MOYER
Of the Vulcanite Portland Cement Company

Discussions by Cloyd M. Chapman and W. M. Kinney

TO arrive at a scientific and at the same time practical method by which to properly proportion the aggregates for Portland-cement concrete we must examine the larger available aggregates and so graduate them in size of particles that the smallest percentage of voids results and, consequently, that less mortar is required to obtain maximum density and therefore maximum strength. The principal requisite is the making of a sufficiently dense and rich mortar to bind together pebbles or crushed stone by entirely filling the voids. The study of this subject must be more particularly directed towards the proportioning of sand, Portland cement and water. The grains of sand must be bound together and the voids between the grains entirely filled with Portland-cement paste. It is the proportioning of this paste that we must study in order to determine the amount of cement and water which shall be added to any particular, available sand.

WEIGHT AND VOLUME OF CEMENT

In figuring proportions, we must determine the amount of Portland-cement paste required to fill the voids in the sand. Experiments made by S. Warren Hartwell would indicate that 110 lb. of Portland cement mixed with 25 per cent. of water are required to produce 1 cu. ft. of paste. The cement must be measured by weight and not by volume, for it has been found that 110 lb. of Portland cement will occupy 1.12 cu. ft. if measured loosely and dry, while if packed tightly it will occupy only 0.96 cu. ft. If 94 lb. of Portland cement is figured as 1 cu. ft., there is not enough cement in the concrete.

Therefore, in using a sand in which there is found to be 38 per cent of voids, the proportion would be 110 lb. of cement to 2½ cu. ft. of sand, or 1 cu. ft. of cement paste to 2½ cu. ft. of sand. If it is necessary to use the bag (94 lb.) as the unit for measuring the cement, the proportions should be computed as follows:

$$94 : 110 : : 38 : x$$

from which $x = 44$ per cent, which calls for a proportion of 1 : 2¼. Therefore, using the bag as a unit, the proportions will be 1 bag of cement (94 lb.) to 2¼ cu. ft. of sand. It is certainly impracticable to change the size and weight of the package, and it is convenient to use the package as a unit for measurement. Therefore, the actual percentage of voids in the sand should first be calculated and then arbitrarily increased by means of the above method.

PROPORTIONING THE MORTAR

There are various methods of determining the amount of Portland-cement paste required to fill the voids in the sand, among which are (1) the determination of the percentage of voids by the specific-gravity method, and (2) by the water test (that is, the volume of water required to fill the voids); (3) experiments to determine directly the required amount of paste by measuring the volumes of mortars of various proportions, and (4) making up the mortars into briquettes and breaking them in 7 and 28-day periods.

[The descriptions of the specific gravity and water methods, because so well known, are omitted here. The third method, while also previously described, is treated briefly because the discussions which follow are based, in part, thereon.]

EXPERIMENTS WITH MORTARS OF VARIOUS PROPORTIONS

Pour 200 cc. of dry sand into a glass very slowly, tapping the bottom and sides so that it will settle in as dense a mass as possible. Then pour out the sand and determine its weight to a hundredth of an ounce. Measure out several more 200-cc. samples of sand, weighing each time as a check on the quantity of sand in each sample. Then determine the volumes of cement paste required to be mixed with the 200-cc. samples of sand to give the various proportions under investigation, and measure out the necessary amount of cement by weight, assuming the weight of cement to be 110 lb. per cubic foot. These data, for various proportions, are given in Table 1. The following proportions, by volume, of cement paste to sand are suggested for investigation: 1:1½, 1:2, 1:2¼, 1:2½, 1:2¾, and 1:3.

TABLE 1—WEIGHT OF CEMENT REQUIRED FOR A GIVEN VOLUME OF CEMENT PASTE

1 Cu. Ft. of Paste Contains 110 Lb. of Cement; Therefore 100 cc. of Paste Contain 6.22 Oz. of Cement

Proportions by volume	Volume of cement paste, cc.	Volume of sand, cc.	Weight of cement required, oz.
1:1½	133	200	8.27
1:1¾	115	200	7.16
1:2	100	200	6.22
1:2¼	89	200	5.53
1:2½	80	200	4.97
1:2¾	73	200	4.55
1:3	66	200	4.11
1:3¼	62	200	3.86
1:3½	57	200	3.55

Mix each sample of cement with 25 per cent of water, then with a 200-cc. sample of sand, and tamp the resulting mortar into the graduated glass, a little at a time, with a flat-end stick. Note the volume occupied by the tamped mortar.

The object of this test is to ascertain what proportion with a given amount of sand will produce maximum density with a minimum amount of cement. Since the same amount of sand is used in each sample, it is evident that with too much cement the volume of the mortar will be increased. Therefore, in progression from the leanest to the richest mixture, that sample which first starts to increase the volume of the mortar is the one which contains the correct proportions for that particular sand.

TESTS OF BRIQUETTES

The reason for using 200 cc. of sand in the previous experiment is to obtain sufficient mortar to make three briquettes. By inverting the glass and jarring the top against a rigid surface, the mortar will be released, usually in a solid mass. Make up each sample of mortar into briquettes, store in a moist closet and break in 7 days.

This strength test is a check upon the accuracy of the above tests for the proportions of cement to sand which will produce maximum density, maximum strength and maximum bonding. The results of the four tests should agree. If they do not, the tests should be made again. If there is still a considerable variation, wash the sand and retest.

COMPARISON WITH OTTAWA SAND AND VALUE OF SCREENINGS

It has been proposed in various specifications to test sand by comparison of its strength with that of standard Ottawa sand. This might cause the rejection of a good sand, for if the comparison is made with 1:3 mortar for each sand, the sand under investigation may not show proper strength in those proportions. The percentage of voids in each sand should be calculated, the mortars made up in the proportions necessary to fill the voids in each sand, and the briquettes tested for tensile or crushing strength. Each mortar will then be of maximum density for its respective sand, but different proportions are of necessity used. The comparison, therefore, should be made not on the basis of mortars of the same proportions but on mortars of maximum density.

If screenings or quarry tailings passing through a ¼-in. mesh sieve are used in place of sand, their voids are determined in the same manner as those of sand, previously described. The tailings, however, should be of such size that not more than 20 per cent passes through a No. 50 sieve and not more than 10 per cent through a No. 100 sieve.

Trap-rock screenings make a very excellent substitute for sand; in fact, they will make a far tougher and stronger concrete than the best sand. Poor stone screenings, however, such as soft limestone, marble, sandstone, etc., do not make as good a mortar for concrete as does good sand.

PROPORTIONING THE LARGER AGGREGATES

Let us now consider the proportioning of the larger aggregates, keeping in mind that the voids in these aggregates are to be filled with mortar as previously described. It is sometimes best to use two sizes of stone, a large size and a smaller size; the smaller size, however, should all be retained on a ¼-in. mesh sieve.

In order to ascertain the best mixture of the smaller and larger sizes of stone or pebbles, make a receptacle which will hold a little over 4 cu. ft. (or use a 15-in. sewer pipe). Measure 3 cu. ft. of the larger stone and 1 cu. ft. of the smaller stone. Mix well together, place in the receptacle and note the space which it occupies. Empty the receptacle, measure 2 cu. ft. of the larger stone and 2 cu. ft. of the smaller stone, mix as before and mark the space occupied. Vary the proportions in this manner, always adhering to a total of 4 cu. ft. The mixture which occupies the least space in the receptacle will make the densest concrete.

The percentage of voids should then be determined either by test or by weighing the stone or gravel and referring to a table giving the percentage of voids for different weights of various kinds of aggregate.

The percentage of voids being known, the parts of stone required for various proportions of mortar to fill the voids can now be found.

CONCLUSION

It may reasonably be stated, therefore, that aggregates proportioned as above described produce a concrete which is denser and stronger than aggregates not so proportioned. Thus, with a given aggregate and an arbitrary specification of 1:2:4, a weaker concrete might be obtained than if the aggregates were properly proportioned in accordance with the principles above described and the proper proportions proved to be, for example, 1:2½:4¾.

If these principles are kept constantly in view, no engineer, without previous knowledge of the aggregates that are going to be used, can conscientiously write a specification and arbitrarily specify 1:2:4, 1:3:6, or whatever his favorite formula may be.

Discussion by Cloyd M. Chapman, Engineer of Tests, Westinghouse Church Kerr & Company

As a broad, general proposition it is probably true that the densest concrete is the strongest and that the determination of voids in fine and coarse aggregate by the various methods given in the paper will assist in proportioning a concrete of maximum density. But in any given case the engineer is not dealing with broad, general conditions. He is dealing with the particular materials available at or comparatively near the site of the proposed work. These materials may or may not be of an unusual character. Whatever method is employed for determining the proportions to be used in the concrete it should be one which applies to all cases and to that particular one especially.

The author states that the proportion of cement to be added to a sand may be determined by the simple method of observing the combination of sand and cement which begins to expand the volume of the mixture. But sometimes this fails to work. We have tested a sand which gave the following volumes when mixed with various proportions of cement:

Proportions	1:2	1:2½	1:3	1:3½	1:4
Volume	126	120	114	112	110

According to this the 1:4 mixture ought to be rich enough, yet a 1:3 mixture gave tensile strengths as compared with Ottawa sand as follows: 7 days, 47 per cent; 28 days, 50 per cent—hardly a suitable material for good concrete work.

The statement is made in the paper that not over 10 per cent of a tailings sand should pass a 100-mesh sieve. We have a record of a test of such a sand of which 18.8 per cent passed a 100-mesh sieve, yet it gave strengths as follows, compared with Ottawa sand (1:3) in tension: 3 days, 159 per cent; 7 days, 166 per cent; 28 days, 174 per cent. In compression the following strengths per square inch at 28 days were obtained: 1:2, 4,250 lb.; 1:2½, 3,500 lb.; 1:3, 3,000 lb.; 1:4, 2,750 lb.; 1:5, 2,000 lb. That can hardly be called a poor sand, yet it would be rejected under such a specification. Another good sand had 21.7 per cent through a 100 mesh.

UTILITY OF TENSION TESTS

The author advocates the tension test of briquettes as one of the four most important tests to be used in determining the value of a sand. As an illustration of how far astray the tension test may lead one, two cases may be cited. One sand gave tensile strength as compared with Ottawa sand as follows: 3 days, 78.8 per cent; 7 days, 104 per cent; 28 days, 109 per cent; and in compression with 2-in. cubes, 28 days, the following: 1:2, 6,750 lb.; 1:2½, 5,750 lb.; 1:3, 5,250 lb.; 1:4, 3,750 lb.; 1:5, 2,500 lb. The other sand gave tensile strength ratios at 3 days of 103 per cent; at 7 days of 104 per cent; at 28 days of 100 per cent; or, not materially less than the other sand. But in compression at 28 days it gave: 1:2, 3,875 lb.; 1:2½, 3,500 lb.; 1:3, 2,500 lb.; 1:4, 2,000 lb.; 1:5, 1,750 lb. In other words, one sand was as strong in compression in a 1:4 mixture as the other was in a 1:2½ mixture, although only a few per cent stronger in tension.

The tension test is a risky guide in judging a material to be used in compression. We do not use it in the case of other structural materials which are used only in compression and why stick so doggedly to it in the case of mortar? How popular would a tension test for brick or hollow tile be among structural engineers?

A claim has been made by some that the percentage of water required to make normal consistency with the sand under test may be a reliable guide to its strength qualities—the more water required the poorer the sand—but we have had a sand which required 33 per cent more water than did standard Ottawa with the same cement, yet the 1:3 tensile strength at 28 days was 196 per cent of that of Ottawa sand. The rule does not always work and I fear the exceptions are so numerous as to cast a doubt on the value of the rule.

RELATION OF VOLUME OF CEMENT TO VOIDS

The author also infers that the proper amount of cement to use with a sand to give maximum density and maximum strength is directly proportional to the volume of the voids. This would be true if the object of adding the cement were simply to fill the voids. With some sands it is not enough that the voids are filled with cement. Some sands having a relatively low percentage of voids make weaker mortar than others having relatively high percentages of voids. A certain cement having 40 per cent of voids, by the displacement method, shows a tensile strength of 115 per cent of that of Ottawa sand at 28 days, while another sample having but 35 per cent of voids shows a strength of only 86.4 per cent at the same age.

The object of adding cement to sand is usually to produce the desired strength. So many conditions affect the strength of the mixture that it is unsafe to conclude that if we know the amount of cement required to fill the voids in a given sand we can then decide what mix to use in concrete. The only safe way is to make up test pieces of a progressive series of mixtures of the materials to be used on the job, including the coarse aggregate, sand, cement, *and the water*, and test these specimens in compression.

The question the engineer on the job must answer is not "how much cement will fill the voids in sand, and how much mortar must I add to stone to fill its voids?" but he must be able to answer most positively the question: "In what proportion must I mix *this* stone and *this* sand and *this* cement and water to produce a concrete which will have the strength required in the structure with a proper factor of safety?"

LIMITATION OF METHOD PROPOSED

With certain kinds of sand and stone, a clean coarse sand and crushed trap rock for instance, the method described by the author would probably give satisfactory results, but if it is depended upon as a universal rule somebody very soon is liable to put in some very poor concrete.

I wish to compliment Mr. Moyer on the work he has done. The tests he advocates give satisfactory results in a majority of cases. These tests have been among those applied to concrete aggregates in the laboratory of Westinghouse Church Kerr & Company for several years. All sands tested are subjected to these tests except that instead of making briquettes for tension tests of the mortar resulting from the "increase in volume" test, we make 2-in. cubes and crush them at the end of 7 and 28 days. But we have tested so many sands which did not follow the general rule that it seems unsafe to depend upon any or all of them when final decision is made.

Discussion by W. M. Kinney, Universal Portland Cement Company

Mr. Moyer's paper presents some very interesting material on a subject which has long received too little attention from engineers and architects specifying concrete for various uses. When we stop to consider that there is frequently a range of 500 lb. either way from the commonly accepted standard of 2000 lb. per square inch in compression, depending upon whether one or another of the local materials available is used, and that an equally great improvement in the strength may be made by varying the ratio of fine and coarse aggregate, while still maintaining the same ratio of cement to volume of concrete produced, it is surprising to note that very little attention has been given to the subject of scientific proportioning of concrete to produce the greatest strength for the least outlay of money. There is no doubt that a more thorough study of the subject would lead to the production of far more suitable aggregate for concrete, placing, as it would, an actual demand on the producer which would have to be met.

It is not uncommon to find, when the specifications distinctly state that the fine aggregate shall pass a ¼-in. mesh and be graded from fine to coarse, and that the coarse aggregate shall be well graded material from ¼ to 1½-in. and the proportions based on these sizes, that the producer will be screening over a 3/16, ¾ and 1½-in. circular screen. It is common practice to accept the apparent inevitable, using the material passing the 3/16-in. screen as fine aggregate, the 3/16 to ¾-in. material for coarse aggregate for reinforced concrete work and the ¾ to 1½-in. material for coarse aggregate for mass work. Such conditions arise largely through ignorance of what is desired rather than through any objection on the part of the producer to giving the right kind of material. To him sand is sand, gravel is gravel and crushed stone is crushed stone. It is up to the user to know what he wants and get it.

DENSITY PROPORTIONING AND PERCENTAGE OF WATER

There is no doubt that density proportioning is the most practical and definite method yet evolved. While it is largely a cut and try method and should be checked by cylinder compression tests there are fewer possibilities of error and the results are not dependent on the use of delicate apparatus. The value of this test in proportioning, however, is not as great as would be indicated by Mr. Moyer's experiments, inasmuch as usually a certain strength concrete is desired and this strength is governed largely by the ratio of the cement to the fine aggregate. The density test, then, has its value in the determination of the proper amount of coarse aggregate to use with a given mortar. This does not mean, of course, that the determination of mortar density is not of great value in obtaining the relative merits of two given sands, as it might develop in an analysis of this kind that one sand would work better than another in lean mixtures and poorer in rich mixtures.

It is questionable whether any great value can be attached to results where a fixed percentage of water is used in all proportions from 1:1½ to 1:3. The percentages of water absorbed by the sand would be double in the extreme case and correspondingly large in the intermediate cases. The absorption would have to be determined and additions made for the mortar containing the larger amount of sand. It is also questionable whether a fixed percentage of water could be used because of the known variation in amount of water required by different brands of cement to produce the same plasticity. It also seems hardly conceivable that 25 per cent water will give anything but a very dry mortar, which would be practically impossible to mix with sand and compact thoroughly. It is common to use 24 per cent for neat briquettes, which are quite stiff and in 1:3 sand mixtures it is not uncommon to use 12 per cent of the total weight of 48 per cent of the weight of the cement.

MATERIAL FOR BRIQUETTES AND VALUE OF SCREENINGS

The making of briquettes of the material left from these density tests is hardly to be recommended. Variations equally as great as those shown could have resulted from the fact that one sample would have dried out more than another during the density test. New samples should be made up in every case. It seems that the argument in this paper against the specifications requiring a mortar strength equal to that of Ottawa sand is not a good one, as the voids in Ottawa sand, being a sand of practically uniform size, are 5 to 10 per cent greater than those of the ordinary sand. The ordinary sand, therefore, has a distinct advantage in percentage of voids and uniform grading. No good sand should fail to equal the strength of Ottawa sand in a 1:3 mixture.

The broad statement made by Mr. Moyer that trap rock screenings make a stronger and tougher concrete than the best sand is an unfortunate one, inasmuch as this will be accepted by many as covering all kinds of screenings from all kinds of trap rock. While it is true that a great many stone screenings give excellent results in laboratory tests, there are few of them which produce good results in the field. This is due to the excessive amount of dust usually present in material of this kind, which has little or no effect under the best conditions existing in the laboratory, but is a serious detriment in the field. It is a safe precaution to require at least double the amount of mixing for stone screenings as for sand. It is better still to pass the screenings over a ⅛-in. screen and use the coarser particles to add to the sand, as sand is usually deficient in the larger particles.

It is well in passing to say a word of caution in connection with the interpretation of tensile tests on mortar. It has been quite conclusively proved that there is no direct relation between the strength of a given mortar in tension and its strength in compression. The ratio varies between wide limits and inasmuch as concrete is used in compression practically exclusively, we should tend toward the compression rather than the tension test. For motors, a 3 x 6-in. cylinder has been found convenient and for concrete the 6 x 12-in. cylinder.

While Mr. Moyer's paper brings out some new and interesting ideas, it is doubtful whether the method of proportioning suggested is a good one. The final proportions determined upon depend upon the void results of the coarse aggregates. This test is a very inaccurate one, involving several variables. It seems to me far preferable to arbitrarily select for a given sand of known value a cement-sand ratio and proportion the amount of coarse aggregate to give the maximum density with this particular mortar.

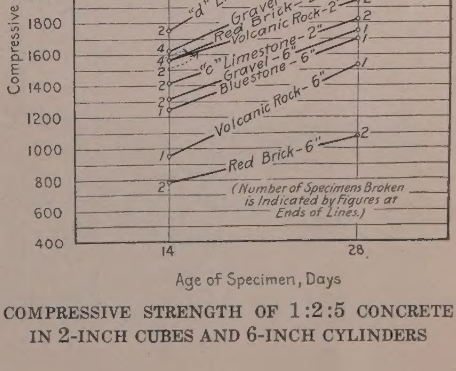
Testing Concrete Aggregates

By CLOYD M. CHAPMAN

Engineer of Tests, Westinghouse Church Kerr & Company

IN an effort made in the laboratory of Westinghouse Church Kerr & Company to develop some more useful form of test for coarse aggregates there was tried, among others, the method proposed in this paper, which seems worthy of further investigation and development by those most interested. The method in its present form consists in determining the compressive strength of a specimen made up of what may be called a skeleton structure of the material under investigation, the interstices of which structure have been filled in with a standardized neat cement or a cement-sand grout, in a sufficiently fluid state to flow into and fill all the voids.

The resulting compressive strength is a function of many variables, yet probably of



COMPRESSIVE STRENGTH OF 1:2:5 CONCRETE IN 2-INCH CUBES AND 6-INCH CYLINDERS a less number than if the stone and grout were mixed together to make a concrete before being placed in the mold.

The details of manipulation are as follows: The molds used are 6-in. cylinders, 6 in. high, and 2-in. cubes. The size of stone used is ¾ to 1¼ in. (averaging about 1 in.) for the 6-in. specimens and ¼ to ½ in. for the 2-in. specimens. Sufficient stone to fill the mold is soaked in water for 24 hours to saturate it so that water will not be absorbed from the grout.

Sufficient grout is made up of a mixture of equal parts by weight of Portland cement and a good grade of sand, screened through a 20-mesh sieve, with about 35 per cent of water added, for the 6-in. cylindrical specimens, and of neat cement with about 45 per cent of water added for the 2-in. cubes.

The wet stones are mixed in with the grout until they are thoroughly coated. The mixed stone and grout are poured on a ¼-in. sieve and the surplus grout allowed to drain off. The stones, coated with grout, are placed in the mold and are packed down well, shaken while being put in place, so that they are in close contact with one another.

The remainder of the grout is well stirred up and poured into the mold near one side, jarring the mold continually so that all the voids between stones will be filled. The top of the specimen is finished smooth by adding grout and by slight troweling after the cement has begun to harden a little.

The 6-in. specimens are stored in a damp closet until broken at the ages of 14 and 28 days, while the 2-in. cubes are stored in water. The specimens are faced with a thin layer of plaster of Paris a few hours before crushing.

The results obtained are shown graphically in the diagram.

It may be noted that the several stones tested ranged over quite wide limits. The points plotted represent averages of from 1 to 4 specimens.

It is greatly regretted that there are not many more specimens of the 6-in. size. There are others under way, but at the time of writing the specimens have not been broken.

It is hoped that this method, together with any others which are considered promising, may be thoroughly investigated, in order that we may have at no very distant date a standard method of testing these materials.

Errors in Determining the Time of Setting of Cement

By G. M. WILLIAMS
Of the Bureau of Standards

THE time of setting of cement is affected by a number of factors, which acting together or separately account for the variable results obtained on the same material in different laboratories.

The variation in results obtained in this investigation are only to be considered as characteristic of the range which may be obtained in practice.

The following factors may cause errors of considerable magnitude:

1. Variation in the amount of work done on the material may cause a difference of more than two hours in the time of initial setting and cause a normal cement to appear quick setting (see Table 1);

2. Variation in atmospheric moisture or humidity of storage during the setting period may cause the initial time of setting to vary as much as two hours;

3. Variation in atmospheric heat or temperature of storage during the setting period may vary the time of setting as much as 1 or 2 hours.

The determination is also affected, to a less extent, by factors peculiar to the Vicat and Gillmore methods.

The important factors to be considered are the working of the cement paste, and the temperature and humidity of the damp closet. The other variables, such as formation of the test specimen and manipulation of apparatus, are of smaller importance compared with those of mixing and curing.

The tests as made at present can be relied upon only to identify normal or slow-setting cements, and may cause a normal cement to appear quick setting.

The results indicate that neither the Vicat nor Gillmore methods for measuring the rate of hardening, even when all external factors are controlled, will give results consistent enough to justify the reporting of such results within the limits of a few minutes; nor can either method be considered as sufficiently accurate for use as a standard.

TABLE 1—EFFECT OF VARIATION IN THE AMOUNT OF WORK DONE IN MIXING THE CEMENT.

Cement No.	How Worked.	Vicat Method. Time of Initial Set.	Vicat Method. Time of Final Set.	Gillmore Method. Time of Initial Set.	Gillmore Method. Time of Final Set.
D-3	Vigorously, 1½ min.	1:43—2:01	....	2:37	....
	Less vigorously, 1½ min.	0:26—0:41	....	1:13	....
2338	Vigorously	2:24	5:14	2:29	4:44
	Less vigorously	0:10	3:50	1:10	4:40
2349	Vigorously	3:03	6:27	3:08	6:27
	Less vigorously	1:23	6:18	1:48	5:23
2360	Vigorously	1:37	6:18	2:12	6:02
	Less vigorously	0:35	6:00	0:50	5:10
2352	Vigorously	2:15	4:45	2:20	4:50
	Less vigorously	0:35	4:10	0:50	6:00

NOTE. Normal consistency used for each cement.

TABLE 2—EFFECT OF ATMOSPHERIC MOISTURE OF RELATIVE HUMIDITY OF STORAGE, AND THE EFFECT OF HEAT OR ATMOSPHERIC TEMPERATURE OF STORAGE DURING THE SETTING PERIOD.
GILLMORE METHOD.

Cement No.	Relative Humidity, Per Cent	Worked 1½ Min. Time of Initial Set	Worked 1½ Min. Time of Final Set	Worked 4 Min. Time of Initial Set	Worked 4 Min. Time of Final Set
		Temperature, 29 to 30° C.			
D-2	25—30	2:25	5:05	2:17	4:30
	38—42	2:35	5:28	2:31	4:36
	38—42	2:35	5:29	....	....
	38—45	2:38	5:28	....	....
	38—45	2:38	5:26	....	....
	50—55	2:48	5:16	2:32	4:41
	60—70	2:52	5:30	....	....
	60—70	2:54	5:32	....	....
	68—72	3:30	5:50	3:13	4:50
	85	3:38	5:56	3:22	5:00
		Temperature, 39 to 40° C.			
D-2	18—28	1:59	3:31	1:58	3:10
	20—30	1:59	3:45	1:57	3:21
	20—30	1:50	3:29	....	....
	20—30	2:01	3:52	....	....
	32	1:39	3:27	1:40	3:05
	32	1:44	3:27	1:46	3:02
	33	1:54	3:20	1:43	3:00
	33	1:55	3:47	1:56	3:18
	70—75	2:26	4:00	2:28	3:25
	70—80	2:36	3:46	....	....

TABLE 3—EFFECT OF ATMOSPHERIC MOISTURE OR RELATIVE HUMIDITY OF STORAGE, AND THE EFFECT OF HEAT OR ATMOSPHERIC TEMPERATURE OF STORAGE DURING THE SETTING PERIOD.
VICAT METHOD (STANDARD TEST SPECIMENS).

Cement No.	Relative Humidity, Per Cent	Worked 1½ Min. Time of Initial Set	Worked 1½ Min. Time of Final Set	Worked 4 Min. Time of Initial Set	Worked 4 Min. Time of Final Set
		Temperature, 29 to 30° C.			
D-2	25—30	....—2:20	5:07	....—2:18	4:45
	32—42	2:28—2:38	5:47	....	....
	32—42	2:29—2:44	5:42	....	....
	28—45	2:31—2:37	5:39	....	....
	28—45	2:28—2:36	5:29	....	....
	38—42	2:28—2:38	5:47	....	....
	38—42	2:29—2:44	5:42	....	....
	38—50	2:16—2:23	5:49	....	....
	38—50	2:29—2:35	5:58	....	....
	38—50	2:07—2:20	5:35	....	....
	42—52	....—2:38	....	....	....
	42—52	2:38—2:51	....	....	....
	42—52	2:23—2:32	5:54	....	....
	42—52	2:31—2:41	5:46	....	....
	50—55	2:30—2:35	5:20	....—2:20	4:51
	68—72	2:26	4:55	2:02	4:39
	85	2:04—2:12	5:12	1:45—1:53	4:20
		Temperature, 39 to 40° C.			
D-2	18—28	1:27—1:31	2:58	1:27—1.30	2:54
	20—30	1:42—1:49	4:05	1:30—1:34	3:13
	20—30	1:30—1:36	3:33	....	....
	20—30	1:51—1:56	3:57	....	....
	32	1:41—1:47	3:48	1:32—1:36	3:16
	32	1:41—1:48	3:56	1:36—1:39	3:23
	33	1:53—1:56	3:33	1:49—1:55	3:05
	33	1:52—1:55	3:34	....—1:51	3:04
	70—75	1:40—1:45	3:00	1:38—1:41	2:52
	70—80	1:49—1:57	3:24	....	....

Ozone Treatment of Sewage at Trenton Abandoned

Test Plant Gives Unsatisfactory Results and Is Abandoned on Recommendation of City Engineer

IN the early part of 1913 a sewage-disposal plant, in which ozone was to be the chief oxidizing agent, was installed for the purpose of treating the sewage from the Municipal Hospital at Trenton. The company contracting for the installation of this device had originally proposed to install a larger and similar plant to treat a portion of the sewage of the whole city. Such plans were presented to the State Board of Health. The company guaranteed to the city that not only would the sewage be settled and disinfected but that the effluent would be oxidized and nonputrescible.

The disposal plant, as described in the 1913 report of Francis E. Daniels, director of the water and sewerage division of the State Board of Health, consisted of a circular tank of a modified Imhoff type with a central ventilating well from the sludge compartment. The tank was built of steel and was divided into sectors by vertical, radial, steel walls, the flow of sewage being alternately toward the outer wall and then toward the inner wall. In the last sector provision was made for adding the ozone to the settled sewage. Information relative to the quantity and concentration of the ozone could not be obtained. The sewage received a much larger period of settling than seemed necessary, being from 10 to 15 hr., and on leaving the tank was black in appearance.

PLANT ABANDONED

It does not appear, the report states, that the expectations of the company have been realized. The following report of A. C. Gregory, city engineer, led to the abandonment of the plant as far as the ozone process was concerned:

"I wish to call your attention to the sewage-disposal plant built at the Municipal Hospital. The plant was built at a contract cost of $1750 and went into operation on or about Jan. 21, 1913. By the terms of the contract between the city and the contractors a period of thirty days was to elapse before any payment of the cost of the plant was to be made. If during such thirty days the plant worked to the satisfaction of the engineer of sewers and water, one-half of the contract price was to be paid. The remainder was to have been paid at the expiration of sixty days upon certification by the engineer that the plant was satisfactory in every detail.

"From the first the plant has not been satisfactory, and upon the expiration of the sixty days cited in the contract further time was granted the contractors in order to give them everything fair in the way of opportunity to demonstrate the efficiency of the plant. A sewage-disposal plant such as is required at the hospital should render an effluent that is at least non-putrescible. The machinery of the plant should work smoothly and constantly.

"While we have made no chemical or bacteriological tests of the effluent, it is evident to the senses that a condition of non-putrescibility of the effluent has not been attained. Very shortly after being exposed to the air it becomes septic in appearance and at times has been an extremely malodorous feature of the atmosphere in the neighborhood of the hospital. The hospital and township authorities, in addition to the neighboring residents, have made many complaints of the evil-smelling effluent.

"There has been nothing approaching constancy of operation of the pumping machinery. Breakdowns have been frequent, at which times the sewage has accumulated in the sedimentation tank, backed up in the sewer connections and caused a large amount of annoyance and anxiety.

"By way of relieving such conditions, the writer has on several occasions taken laborers to the hospital and pumped the tanks out by hand.

"In short, the work of the plant has been unsatisfactory and there is little to indicate that it will give us satisfaction in its present shape. The writer, therefore, respectfully suggests that steps be taken to have the contractors, in accordance with the terms of their contract, remove the plant, or such part of it as may be unsatisfactory and inadequate, in order that relief may be given the hospital authorities from the present intolerable conditions."

Making Railroad Fill from Pontoon Bridge

Novel Device Used in Carrying Canadian Northern Railway Across an Arm of Rainy Lake Three Miles Wide

ABOUT half way between Winnipeg and Port Arthur it was found desirable to locate the main line of the Canadian Northern Railway across an arm of Rainy Lake. It was decided to make a rockfill for the crossing, which was 3 mi. long, and in order to avoid the necessity of driving piles to support the work trains a special pontoon arrangement was devised.

Surveys for determining the nature of the permanent construction were started in 1908, and it was found that the depth to rock bottom was so great that the piers for a series of steel bridges would be very costly. The mud overlying the rock was too soft to hold clusters of piling, but was also pronounced too stiff to allow rock-filled cribs to sink to foundation.

STUDY OF LAKE BOTTOM

Study of the lake bottom was carried on through the ice for two winters, and was then finished on open water by what is said to have been a more satisfactory method. The summer soundings were made from a 22 x 34-ft. barge with a driving machine over a central well opening. A 70-lb. hammer was used to sink extra-heavy 1¼-in. strain pipe to refusal. This pipe was joined together in 10-ft. sections by threaded couplings, and steel specials for point and cap were provided. As many as twenty-eight soundings in a day were taken with this equipment.

With this detailed information about the lake bottom at hand, it was decided to make a solid rockfill for the entire crossing. When the most economical projection of the line across the water had been determined, it was found that the fill would have to be more than 60 ft. deep in some places and that a total of about 1,000,000 cu. yd. of rock would be required. Quarries were located on company property near the lake shores, so that an average haul of only 1 mi. was necessary. The line was located so as to take advantage of five rocky islands along the route, and of course rock from these was used in starting fills out from their shores. In October, 1910, two model C 95-ton Bucyrus steam shovels were put to work loading broken rock into 12-yd. standard-gage dump cars, and two more were added a few months later. All four shovels were in commission until the fall of 1912, and during this time each sometimes handled as much as 50,000 cu. yd. of rock per month.

FLOATING TRACK OVER DUMP

One of the difficulties encountered at the outset was the necessity for some method of dumping the rock so that it would give no trouble in settling into the desired position. A very satisfactory solution of this problem was devised in the shape of a dumper consisting of two 6-ft. plate girders 30 ft. apart, with floorbeams 30 ft. apart on the end at which dumping was done, and shorter distances apart for the remainder of the truss. The track was supported on stringers at the center, leaving distances of 11 ft. between girders and the ends of the ties through which the material was dumped. Originally the girders were 120 ft. long, but they were afterward lengthened to 140 ft. so as to carry six 12-yd. cars at one time.

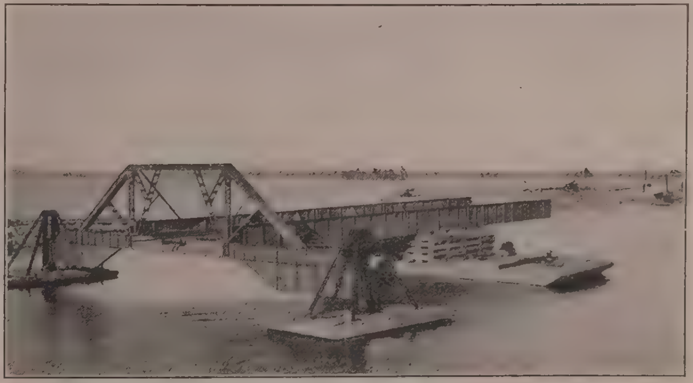
The support for the truss, 75 ft. from the embankment end, was a 32 x 112-ft. barge capable of carrying 200,000 lb. for each foot of displacement. When not resting on the head of the bank, the shore end was supported by two pontoons placed about 40 ft. apart. A girder with a portal entrance and bracing carried the weight from the shore end of the dumper to these pontoons. The truss was supported on the main barge by cribbing so that it could be raised or lowered according to the height of the finished embankment above water. For most of the work this was about 15 ft. above the lake surface.

At each end of the barge were capstans from which lines ran out nearly perpendicular for nearly 1000 ft. to the shores of small islands or to a 5-ton anchor block of stone. A forward line was carried from a winch on the barge and used for warping the barge in moving forward.

Two heavy saw logs were attached to the shore end of the barge, with the small ends toward the shore, so that they formed a support for the track until the head of the bank was brought entirely up to grade, usually a distance of not more than 2 ft.

Dumping could generally proceed until the top was within 2 ft. of grade before it

MAKING RAINY LAKE ROCKFILL FROM PONTOON BRIDGE



VIEW OF DEVICE, SHOWING MEANS OF ADJUSTMENT was necessary to move ahead. When the dumper was first built it was anticipated that about 1 hr. would be required to move the device, but in actual practice only 3 or 4 min. were needed, and dumping could proceed as soon as the track was laid over the space left vacant on the head of the bank. Usually the whole operation consumed about 15 min.

When the fill had been brought up sufficiently near the surface the floating bridge was moved ahead and the widening and finishing up of the grade was left to be done by side dumping. About one-third of the grade was usually added in this way after the floating bridge had moved on.

In closing up the work the gap finally became too short to permit the use of the barges supporting the dumping track. The embankment was then gradually advanced from the east until the gap was short enough so that the 140-ft. steel girders could be floated in on the main barge and bearings secured for them on opposite faces of the two approaching fills. The girder ends were then blocked up on the rock and the barge towed out. After the rock voids near the girder supports had been well filled and allowed to settle, the dumping was proceeded with as before from the track on the girders. When the girders were no longer necessary, they were dismantled and removed.

As to the operation of the dumper, the contractors report that there was no delay from the time the dumper was first installed, except once when the rock embankment settled quickly and for a short time there was danger of a locomotive and cars going into the lake. The dumper was carried when empty by the main barge and pontoons so that there was never any danger of it sinking. The entire cost of the dumper did not exceed 1½ cents per cubic yard for the amount of work done by it, and the equipment is in practically as good shape as when constructed.

The fill was made by Johnson & Carey, subcontractors, under Foley, Welch & Stewart, general contractors for the Canadian Northern Railway. E. S. Johnson designed the dumper specially for the Rainy Lake work and has obtained a patent on the device, the superstructure of which was constructed by the Minneapolis Machinery Company.

Bulk Cement Becoming Popular

In May 27,670 bbl. of Universal Portland cement were shipped from the Chicago plant, the largest single consumer being the Chicago, Milwaukee & St. Paul Railroad, taking 17,567 bbl. for track elevation work in Chicago. Over 3000 bbl. have been shipped from Buffington, Ind., to Duluth, approximately 480 miles, without complaint of caking due to the long shipment. No special care has been used in the picking of cars, other than the usual run of box cars that receive the O.K. of the railroads for loading with grain.

WATERTOWN ARSENAL tests made during 1913 include 2310 gun and ordnance tests and 758 other tests, most of them for private parties, comprising tests of steel columns, comparisons of testing machines and tests of cordage, rope fastening, pneumatic hose, concrete cylinders, slabs, columns, blocks and bricks, wire, shackels and chains.

Interstate Difficulties over Water Rights

Enumerated by Committee on National Water Law of the American Society of Civil Engineers

The American Society of Civil Engineers has appointed a special committee to ascertain the needs for a National water law and to prepare a preliminary draft of such law, if it appears necessary for the protection of existing rights and to encourage new engineering development. This committee consists of F. H. Newell, chairman; George G. Anderson, Charles W. Comstock, Clemens Herschel, W. C. Hoad, Robert E. Horton, John H. Lewis, Charles D. Marx and Gardner S. Williams.

The committee has appealed to the members of the society for assistance in collecting data and has sent to each blanks for recording information on existing and proposed projects having an interstate bearing. The enumeration of the possible difficulties between states as to water rights is illuminating and is, therefore, reproduced below.

The difficulties may occur:

1. From the taking of water across State lines;
2. From the use of water in an upper State which may ultimately jeopardize the quantity and quality for use in a lower State;
3. From appropriations on border streams where the controlling works are in two States;
4. From the storage of water in an upper State for transit in stream channels through several States and use for navigation, power, etc., at the lower end of the stream;
5. From appropriations within a State on a navigable stream or its tributaries, where such appropriation has affected, or may affect, navigation, thus creating conflict in jurisdiction between the State and Federal governments;
6. From appropriations under State law on Federal lands which cannot be secured because of withdrawal for power purposes;
7. From appropriations under State law on streams where water has been reserved for future use on Indian reservations, by early United States treaties with the Indians;
8. By storage or diversion from navigable lakes within a State where conflict exists as to State or Federal jurisdiction;
9. From statutory enactments, such as those of New Jersey and California, which prohibit the diversion of water for use in adjoining States;
10. Because of failure of one State to enforce the right of condemnation in adjoining States, as in the case of New York's water supply;
11. Because of judicial decisions in one State prohibiting the diversion of water from one drainage basin into another, or across State lines (such as the Idaho case of Walbridge vs. Robinson, 125 Pacific p. 812);
12. From the construction of unsafe works in one State which menace lives and property in adjoining States;
13. From the drainage of swamps or lakes in one State which removes this natural regulation of flow and may cause destructive floods in adjoining States;
14. From the pollution of water in one State to the detriment of lower States;
15. Because of Federal game preserves which prevent water appropriations under State laws, and
16. Because of international treaties and controversies where State or Federal jurisdiction is questionable.

Direct-Explosion Pumps for Egyptian Government

Eighteen Units Ordered for Drainage of Lake Mareotis, Near Alexandria

DIRECT-EXPLOSION pumps of the Humphrey type—eighteen units, each with a capacity of 100,000,000 imp. gal. daily against a 20-ft. head—have been ordered by the Egyptian Government for the drainage of Lake Mareotis at Mex, near Alexandria. The pumping plant will be one of the largest in the world. The great size of the pumps may be judged from the fact that each unit is to be capable of delivering between two and three times that delivered by each large Humphrey pump unit installed at the Metropolitan Water Board's pumping station at Chingford, near London. The following approximate dimensions of the pumps for Mex are given by the "Engineer," London:

The combustion chamber will have a maximum internal diameter of 8 ft. 8 in., and its height will be about 14 ft. The water valve box will be 8 ft. 8 in. in diameter and 7 ft. high, and will be fitted with 100 valves of the hinge type, specially designed to enable any valve to close upon an obstruction, such as a piece of wood, without throwing undue stress on the hinges. The design is such that on the next stroke, when the obstruction has been removed by the rush of water, the valve will automatically readjust its position and close fairly upon its seat. This type of valve is a result of careful experiment and test.

BENDS

All the main castings will be of steel, and will be carried upon a cast-steel bend connected to the play pipe. This bend will be in two parts, making up the 118.5 deg. required to connect with the inclined play pipe. At Chingford the bend has an angle of 90 deg. and is connected to a horizontal play pipe, which in turn is connected through a second 90-deg. bend to a vertical conical water tower. At Mex, however, there will be only one bend, and the play pipe will slope upward, so as to deliver the water at the required elevation in the discharge basin. In order to reduce the velocity of the water at the exit, the play pipe will end with a long conical portion, giving a 12-ft. diameter outlet. Not only does a sloping play pipe eliminate one of the bends and give rise to a simpler construction, but it is said to have the additional advantage that the vertical components of the forces due to momentum of the moving masses of water in the combustion chamber portion and play pipe portion respectively are balanced.

The anthracite gas plant, capable of gasifying 44 tons per day, will be of the self-vaporizing type. There will be nine producers, one of which will be a spare. The producers will be of the luted type. The gas from the collecting main will pass through two large gas-cooling towers, and then through dry scrubbers into a gas holder of 10,000 cu. ft. capacity, which will be used for measuring the gas during official trials.

Lehigh University's Athletic Field

Structures for Outdoor and Indoor Sports Arranged on Three Terraces, One of Which Has a Concrete Stadium

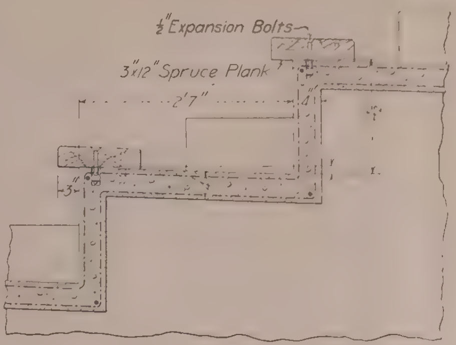
An athletic field comprising a football and lacrosse field, baseball diamond, ¼-mile elliptical running track with a 220-yd. straightaway practice field, baseball cage, swimming pool, gymnasium, field house, superintendent's cottage, reinforced-concrete stadium and parking space for automobiles is about finished for Lehigh University at South Bethlehem, Pa. It is located at the east end of the university campus and its general arrangement is shown on the accompanying plan. The gymnasium is the gift of Charles L. Taylor, of Pittsburgh, Pa., an alumnus of the university, and the entire lay-out is to be known as "Taylor Field."

As the terrain had a steep slope it was found necessary to arrange the grounds into three terraces; an upper field at El. 53, a lower field at El. 13 and an intermediate terrace used as a parking space at El. 44. The lower field contains the football and lacrosse field, baseball diamond and concrete stadium.

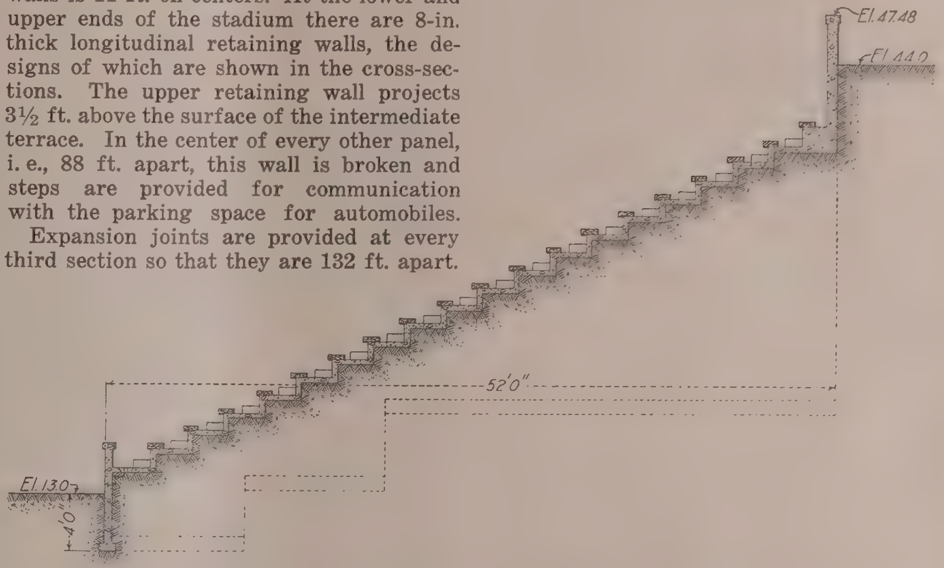
The reinforced concrete stadium almost surrounds the lower field. The south side, 52 ft. wide, is partly on excavation, and partly on reinforced-concrete walls, being on the slope between the two fields; the remaining three sides are 40 ft. wide and are on the flat lower field. The seats are formed by concrete steps 31 in. wide and 16½ in. high, the slope being 1 on 2. On these steps are laid 3 x 12-in. dressed spruce planks 13 ft. 4 in. long, projecting 3 in. outside of the concrete step and held in place by three staggered Cinch expansion bolts spaced 6 ft. on centers. The steps have a slope of 1 in. so as to form a gutter for draining rain water away from the planks. The seat tiers drain at the rate of ⅛ in. per foot to the aisles, which are spaced 44 ft. apart. In the aisles there are inserted between seat tiers one step 8 in. high and 15½ in. wide. To facilitate drainage, aisles and steps are at a slope of ⅛ in. to the foot. This arrangement for drainage is said to be so efficient that twenty minutes after a heavy rainstorm the seats are dry.

The seat tiers were first built on a structural reinforced-concrete substructure, but this design was later abandoned for solid walls 12 in. thick. The spacing of these walls is 11 ft. on centers. At the lower and upper ends of the stadium there are 8-in. thick longitudinal retaining walls, the designs of which are shown in the cross-sections. The upper retaining wall projects 3½ ft. above the surface of the intermediate terrace. In the center of every other panel, i. e., 88 ft. apart, this wall is broken and steps are provided for communication with the parking space for automobiles.

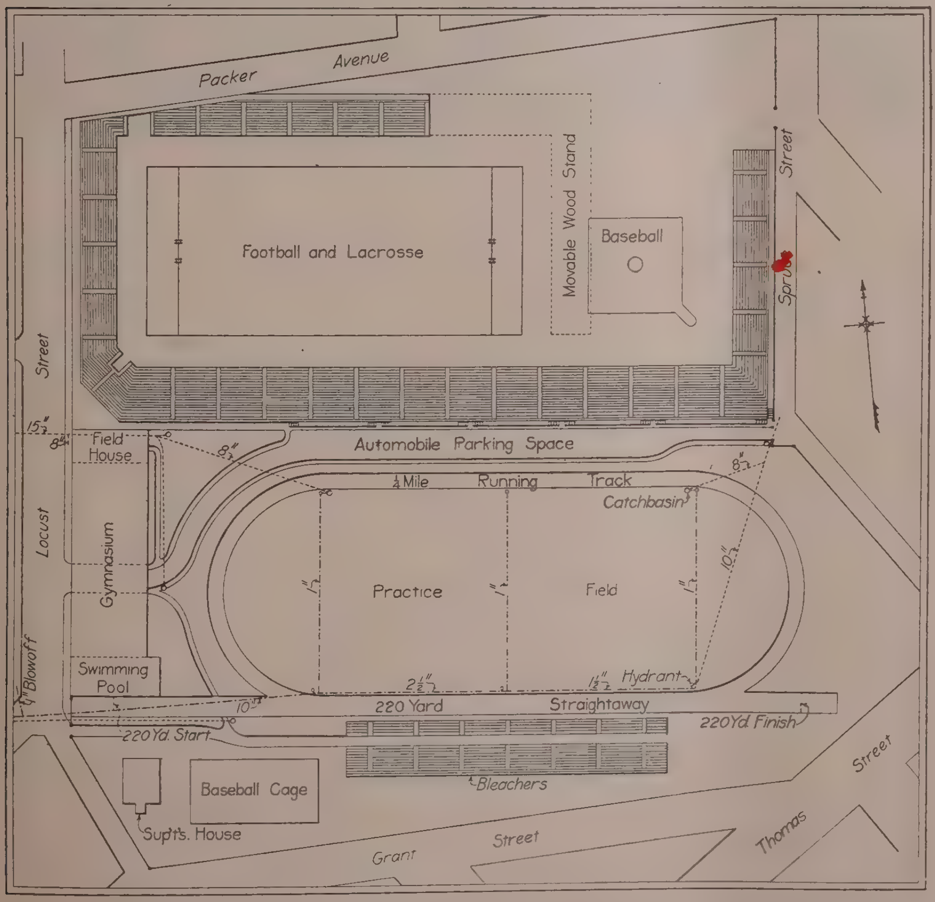
Expansion joints are provided at every third section so that they are 132 ft. apart. These joints are painted with one coat of tar so as to prevent bonding.



DETAIL OF SEAT TIERS



CROSS-SECTION OF BLEACHERS, SHOWING SUPPORTING AND RETAINING WALLS



PLAN OF TAYLOR FIELD, GIVING RELATION OF FIELDS AND BUILDINGS

At the present time only part of the south section has been completed, but contracts have been let for eleven more sections on the south and west stands, and additional sections will be built as soon as the necessary money has been obtained. The alumni associations in the various cities are each donating the money to build one section, and the names of the associations are placed on bronze tablets at the top of each section.

Seats for five hundred spectators are provided in each section, so that the capacity of the finished stadium will be 15,000. In addition there will be standing room for about 5,000, so that the total capacity will be about 20,000.

The athletic field and the reinforced-concrete details were designed by Charles W. Leavitt, Jr., civil and landscape engineer, and the gymnasium and field house were designed and supervised by Henry Hornbostel, consulting architect, both of New York City.

The work is carried out under contract, F. E. Spinner, of New York, doing the grading and track work, the Ochs Construction Company, of Allentown, Pa., part of the south stadium, and Williams & Richardson, of Scranton, Pa., have just been awarded the contract for eleven more bays of the stadium. The swimming pool, the field house and the gymnasium were built by the Chas. McCaul Company, of Philadelphia, Pa. The work is being done for Lehigh University, of which Dr. H. S. Drinker is president.

Modern Coal and Ash Handling System

Installation Adopted at the Gorge Power Station, near Akron, Ohio, as the Best of Three Arrangements Investigated

By JAY C. LATHROP
Civil and Mechanical Engineer, Baltimore

A UNIQUE coal-handling system of considerable interest has recently been installed adjacent to the new Gorge power station of the Northern Ohio Traction & Light Company, near Akron, Ohio. The decision to locate the Gorge power station in the gorge of the Cuyahoga River was due not only to the abundance of water for boiler feed and condensing purposes, but also to the fact that the facilities for delivering coal from the railroad cars to the boilers by gravity were excellent, on account of the steep slope of the banks of this river. Studies were made of three separate systems of handling the coal.

Consideration was first given to concrete coal bunkers directly under the railway siding. Under these bunkers a tunnel was to be provided in which a traveling crusher car would work. Below this would be a second smaller tunnel in which cable cars would be installed which would pass over the roof of the boiler room and deliver the crushed coal into small hoppers over each boiler. The second system investigated was a steel-and-concrete bunker to be located at the east end of the boiler room, with a capacity of about 1000 tons. In this case the crusher was to be stationary, delivering into small cable cars which would run the length of the boiler room, delivering into small individual hoppers for each boiler. The third system, which was finally adopted, cost more to install than would have either of the others, but the operation is more simple and there will be fewer chances for breaking down. Its storage capacity is also several times that contemplated under either of the other methods.

SYSTEM ADOPTED

All coal will be delivered over the Pennsylvania in hopper-bottom cars. These cars will pass over 100-ton track scales, where the weight will be recorded, thence over a steel trestle to the bunkers, from which the coal will be dumped into two main bunkers having a capacity of 2000 tons each. The coal will then pass through a 24-in. double-gate coal valve into a traveling crusher car which travels on the lower track. This car consists of a steel-plate bin with a capacity of 10 tons, underneath which is mounted a single-roll Jeffreys coal crusher. The crusher is driven by a 25-hp General Electric 440-volt induction motor. The car is moved by a 5-hp General Electric 440-volt induction motor. All the above apparatus is mounted on a standard-gage railway truck.

The coal will pass from this crusher into small hoppers, each of which will contain approximately a day's supply for a boiler. From these hoppers it will pass through Richardson automatic coal scales into circular wrought-iron chutes leading to the hoppers of the Taylor stokers.

The track scales are located under the Pennsylvania siding a short distance above the power house. The scales have a capacity of 100 tons, which was considered ample, inasmuch as the locomotive will never pass over them, all cars being handled by one of the company's work cars. As the average hopper-bottom car will not hold more than 50 tons and will weigh less than that empty, the margin of safety is considered sufficient. These scales are 46 ft. long and were furnished by the Buffalo Scale Company. Concrete foundations and pit were provided. The scales are provided with a recording beam which stamps the total weight of the car on a card.

BUNKERS

The bunkers were designed after the power station was well under way, but the present scheme was adopted early enough so that the size of the outside columns in the boiler room could be increased enough to care for this additional load. This change was made and the columns were also extended a little above the boiler-room roof and provided with splice plates for the extensions.

It was also found desirable and necessary to build a substantial concrete retaining wall against the rock side of the gorge to prevent slides from above. Under these conditions this wall was placed at such a distance from the boiler room as would be most convenient for the width of the bunker. This wall came up to a point 4 or 5 ft. below the boiler-room roof and the columns supporting that side of the bunker rest upon grillage beams placed on this wall. Each column has a separate grillage consisting of three 15-in. 60-lb. I-beams 6 ft. long, spaced 9 in. on centers. The concrete wall comes flush with the top of these beams.

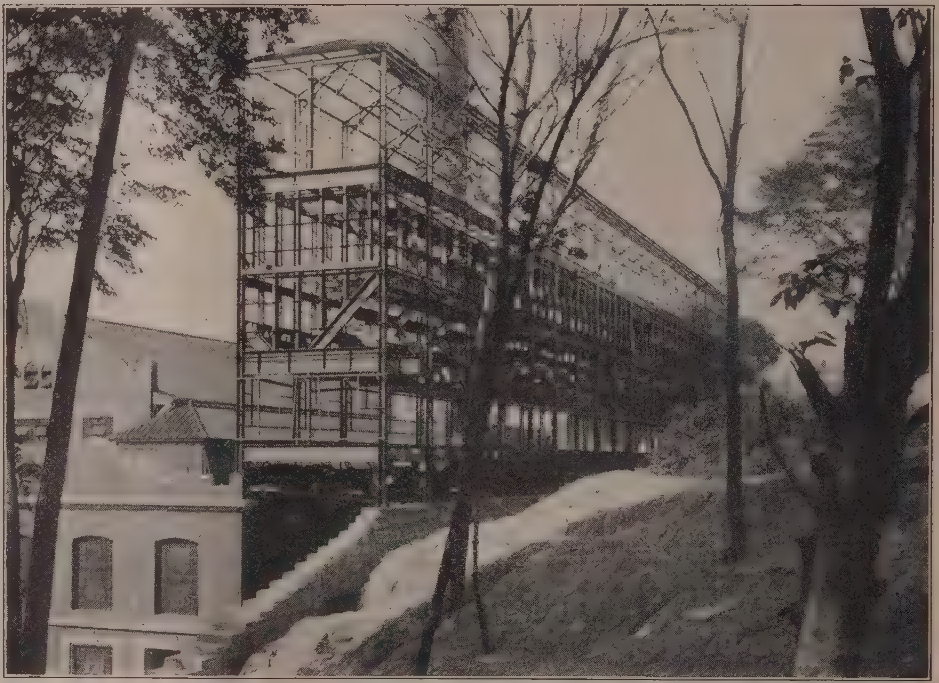
The columns which rest upon the wall are 25 ft. from the center of the boiler-room columns. Each bunker consists of nine bays, three of which are 17 ft. 5 in. long and the other six a foot shorter. This structure is supported by bents on each pair of columns. The bents consist of a plate girder and inclined sides forming the bottom of the bunker, together with cross bracing and girders supporting the track stringers. At the top of each bent is a steel truss which supports the roof. The complete structure was designed to carry a train of loaded coal cars in addition to the weight of the structure and the coal in the bunker. No allowance was made for impact, as the cars will move at a low rate of speed and their weight is insignificant compared with that of the loaded bunkers.

CRUSHER FLOOR

In addition there is another floor, supported by plate girders, about 10 ft. below the bunker. The traveling coal crusher runs on this floor. The small individual hoppers which supply the boilers are hung beneath this floor. The main girders supporting the bunker are made up of 42 x ½-in. web plates and four 6 x 6 x ¾-in. angles with the necessary stiffeners. The inclined girders consist of 20-in. 65-lb. I-beams. A heavy cross bracing to take the outward thrust of the coal on the sides was provided. At the top of the inclined girders, longitudinal reinforced-concrete girders reinforced by heavy structural-steel latticed members are provided running the entire length of the structure. The girders supporting the tracks consist of a 36 x ⅜-in. web plate and four 6 x 6 x ½-in. angles, the top flange being reinforced in a lateral direction by a 15-in. 33-lb. channel. This channel is extended to take care of any cross-bending on this girder due to braking effect. The main columns are built up of a 12 x ½-in. web plate and four 6 x 4 x ¾-in. angles. The section of the column above the track level is much lighter, as it carries only the roof loads; it is built of a 12 x ¼-in. web plate and four 3 x 3 x ¼-in. angles.

The sides, ends and bottom of the bunkers are made of reinforced-concrete slabs varying from 6 to 8 in. in thickness. Concrete walkways are provided on both sides of the main coal track above, and on one side of the coal crusher track below.

In order that there would be as little interference as possible when the coal was


STEEL FRAME OF COAL AND ASH HANDLING PLANT

discharged from the cars, special steel ties have been provided to carry the rails, each being located directly above the cross bracing. The coal is delivered to the crusher car through cast-iron coal valves furnished by the C. W. Hunt Company, of New York City. These valves are carried upon small channels in the bottom of the bunker and are so arranged that they can be operated by means of levers and shafting from the walkway at the side of the crusher car.

COVERING

As the appearance of the rough concrete would not correspond with the roof of the main power station, it was decided that the entire structure should be covered with asbestos protected metal. This metal is to have a buff shade on the exterior which will conform very closely to the terra cotta roofing tile on the main station. Another reason for adopting this covering instead of corrugated iron was the impossibility of painting the inside face after erection. The roof over this bunker will be of the same material carried on the steel frame mentioned above.

TRAVELING CRUSHER CAR AND HOPPERS UNDERNEATH

In order that the windows in the boiler room would be properly lighted this covering was only carried part way down on the south face of the bunker. This leaves one side of the crusher room open to the elements. On the other side of the crusher room and on both sides of the main track room window openings have been provided with Detroit Fenestra steel sash, set in angle-iron frames.

Sixteen Babcock & Wilcox 604-hp boilers are now installed in the boiler room. Most of the coal used comes from the Cambridge district in Ohio, and costs about $1.81 per ton at the station. This coal has a calorific value of 12,600 B.t.u. and approximately the following chemical analysis: Moisture, 3.21 per cent; volatile combustible matter, 39.63 per cent; fixed carbon, 48.70 per cent, and ash, 8.46 per cent.

Inasmuch as the coal used in this station is the principal source of expense, any system which tends to reduce the coal consumption is of direct value, provided the saving in coal more than offsets the additional expense involved in keeping the necessary records. As is well known each type of boiler and each individual boiler has a definite point where its efficiency is the best, that is, where the number of pounds of steam produced per pound of coal is the highest.

RECORDING APPARATUS

In order that this may be determined accurately from day to day complete recording apparatus has been installed in connection with these boilers. As the coal passes from the bunker it passes through a recording scale which measures the number of dumps of a 200-lb. hopper. Thus the total for any period of time can easily be determined. Ordinarily boiler efficiency has been determined by measuring the carbon dioxide present in the flue gases. As the fireman soon learns that it is to his interest to generate carbon dioxide instead of steam, there is liable to be a resulting loss in efficiency. Also it is impossible to determine just how the load is divided among the boilers. For this reason it was decided that steam-flow meters should be placed upon each boiler so that the actual steam generated can be checked back against the coal used. This, in connection with the recording thermometers, which give the temperature of the flue gases, will enable the fireman to adjust feed water, steam pressure, draft, fires, etc., so that each boiler will take its proper share of the load. He can also detect any inefficiency of the boiler caused by soot, scale or poor fuel; furthermore, if the steam pressure should drop at any time the fireman can readily determine whether this was caused by an increase in load or a drop in the amount of steam delivered by a particular boiler due to a bad fire or something of that nature.

The boilers are fitted with Taylor seven-retort stokers. These stokers are driven directly from a shaft connected to the fan engines which furnish the forced draft.

The ashes are dumped into two steel ash hoppers under each boiler. These ash hoppers are lined with firebrick and provided with a spray so that the ashes can be quenched as they drop into the hopper. The hoppers are arranged to dump by hand into an ash car in the basement. The car has a capacity of 54 cu. ft. and is arranged to dump through the bottom.

At present this car is hauled from the basement up an incline to a small trestle where the ashes are dumped into wagons. A steel cable and drum driven by an electric motor is used for this purpose. Later a skip hoist or elevator will be installed and the ashes dumped into standard railroad cars for delivery to various points on the company's system for use as ballast.

The Burger Iron Works, of Akron, were the contractors for the fabrication of the structural steel work, while the reinforced-concrete lining was built by company forces under L. Garrett, superintendent of construction. The covering was furnished and erected by the Asbestos Protected Metal Company, and the steel sash and glazing by the E. F. Hauserman Company, both of Cleveland. The late J. T. Ross, of Cleveland, was consulting engineer on the work, while the writer had direct charge of the designs and supervision of the contract work.

Surface Condenser for Steam Rock Drills

Equipment of Drill Scow for Submarine Work Where Fresh Water for Boilers Was Not Plentiful

By FRANK RICHARDS
New York City

A SPECIAL drill scow for submarine work, with at least one unique feature, has been doing excellent service in channel and harbor improvement work at Bermuda. As is well known, all fresh water available anywhere in the Bermuda Islands is rain water stored in tanks and sold at various prices up to $4.50 per ton. This makes the use of steam in any considerable volume, without recovery of the water, almost prohibitive. A special drill scow adapted to the conditions, operating two large submarine drills, a steam winch and a steam pump, is equipped with a simple surface condensing arrangement so efficient that only 1½ tons of water per week are required for renewal or replacement. Besides the saving of the water, which is most important, there is a considerable saving of coal, there is no exhaust steam and no noise around the work, and there is always pure feed water. Practically no cylinder oil is used for internal lubrication and oil makes no trouble in the boiler.

Before the building of the scow, the drills were located one on each side of the dredger "King George," which necessitated the complete cessation of dredging whenever drilling was necessary. In other words, an expensive dredger had to be temporarily turned into a drill scow. As a considerable amount of rock has been encountered that could not possibly be dredged without blasting, about four days' blasting were required to give two days' dredging, the arrangement resulting in an output of 800 to 1000 tons per week. Since using the drill scow, and alternating the work of drill scow and dredger at different portions of the channel, the average per week has been raised to over 4000 tons.

The scow is 41 ft. long, 25 ft. wide and 5 ft. deep, draws about 15 in. of water, and after six months' continuous service is as "tight as a bottle." The framing is 4 x 8 in. and the planking and deck is 2½ x 12 in. To protect from worming the bottom is covered with three coats of tar and arsenic. The scow is moved from place to place by kedge and warp from the niggerhead of the steam winch, and the moorings are handled from the same, the drum of the winch being used for hoisting. There are four spuds, two 8 x 8 in. and two 9 x 9 in., 34 ft. long and all steel shod. These are located in spruce spud guides 10 ft. long, securely fastened to each corner of the scow. Each spud is hoisted from the niggerhead of the winch through lead blocks and a sheave on top of an 8 x 2-in. upright. It is held down by a wire down-haul pendant and fall secured by an eye bolt in the deck and led to the niggerhead to give it tension.

The boiler is a vertical tubular, 4 ft. in diameter, 6 ft. 6 in. high, with 140 tubes, 3 ft. 4 in. long, the usual steam pressure being 60 lb., gage. The boiler easily supplies the two drills, the air pump and a duplex pump for forcing water into the holes when drilling. This latter pump was found extremely beneficial in removing the material in the soft strata which would fall down and choke the drills.

The air pump used is a 4 x 6 x 8-in. Davidson, and the condenser consists of 160 running feet of 2-in. galvanized iron pipe bolted under the bottom of the scow. Although the scow when working is practically stationary, and the temperature of the sea water in summer is about 75 deg. Fahr. at the surface, a vacuum of 22 in. is easily maintained.

A corrugated iron roof extends fore and aft over the drill track and the steam and exhaust pipes are secured to this. The connections to the drill cylinder and feed engine are by flexible steam hose. The fresh water tank, or hot well, is built of wood in one corner of the scow, and the powder house is located on the deck directly over it. The scow was built by day labor under the direction of the engineer in charge. The cost without the drills was about $4250.

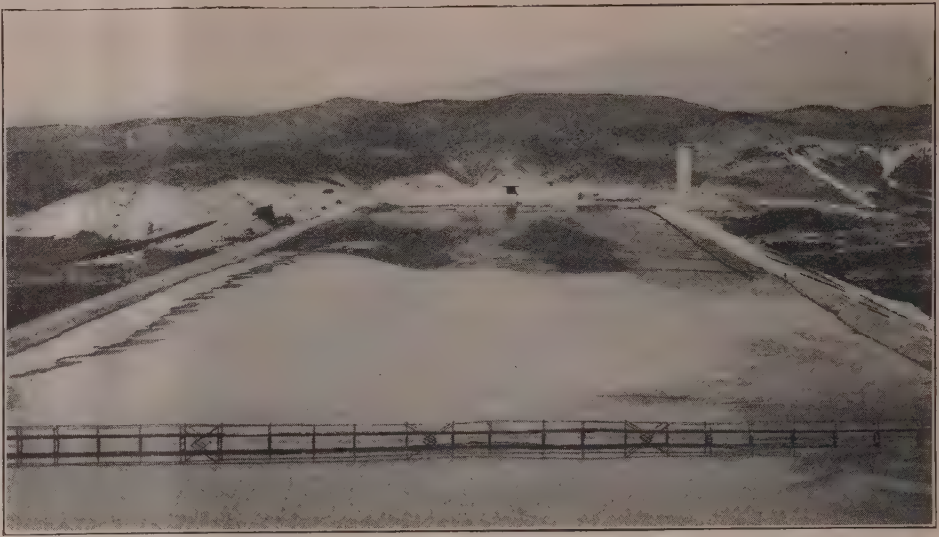
The drills, 5 in. piston, H. A. Ingersoll-Sergeant, are mounted on drill frames, lock-jointed and movable fore and aft on a steel-faced track, with eyes and hook bolts for securing the frames every 5 ft. The longest drill steel used is 35 ft. and the shortest 10 ft. and about 4 lb. of blasting gelatine is used per hole.

CHARACTER OF ROCK

The rock that has to be handled is a conglomerate of varying hardness, from an unstratified hard and close grained material (limestone) to a stratified material composed of the above with an almost sandy stratum between, the latter being probably the most difficult to deal with. Owing to the fact that there is no regularity as to this hard rock it is found to be the cheaper and more satisfactory method to locate the "humps" and charge the holes with a diver. Under ordinary conditions about eighteen holes, 7 to 8 ft. deep, have been drilled per day with one drill.

The scow has sometimes been used in the outer portion of the channel in a moderate ocean swell and has given very fair results, even under these extreme conditions. A second dredger, the "Queen Mary," has recently been added to the equipment and extensive channel improvement is on the program.

For all of the above information I am indebted to W. B. Smith, engineer in charge, St. Georges, Bermuda.



POOL IN WHICH WATER-BORNE MATERIAL IS DEPOSITED IN DAM

Dam Building at 7 Cents a Yard

Crews of Six Men per Shift Are Constructing the San Fernando Earth Dam of Los Angeles Aqueduct by Hydraulic-Fill Method

THE relative behavior of sand and clay when conveyed and deposited by running water is the principle on which five dams have been constructed in California at a very low yardage cost by William Mulholland. In the method he employs centrifugal pumps lift the material from the reservoir site onto the dam, and the flow is so controlled that the clay settles and is compacted on the center line of the structure and here forms an impervious core. The coarser material, which is pumped in at the same time as the clay, is allowed to settle so as to flank this central deposit, and thus there is built up a pressure-compacted clay core wall supported on either side by coarse, porous material.

As the dam is built up a shallow lake is maintained on its top by continually diking up the earth along the crest of both upstream and downstream slopes. Into this lake, along its borders, pour the discharges from the pumps that lift the material, and by means of a vertical pipe which acts as an overflow in the center of the lake the water level is kept down to just the maximum height consistent with the best results. The theory on which this plan works is that the sand and heavier material carried by the water are deposited very quickly near the outfall of the discharging pipe, while the lighter particles of silt and clay are carried in suspension longer and seek the lowest level in the still water of the lake. The system of sorting the materials thus becomes automatic, as the bottom of the lake naturally takes a gradual slope downward toward the central point, and the water which overflows into the downspout is nearly clear. It only remains to shift the discharge pipes occasionally to maintain an even distribution and adjust dike and overflow levels to keep pace with the progress of the work.

FERNANDO DAM

The Fernando reservoir is one of the smaller storage units on the Los Angeles aqueduct and is located about 25 miles from the city. The dam is being constructed by the hydraulic-fill method and June 1 was about 65 per cent completed. It will be 145 ft. high, 1700 ft. long on the crest, and is to contain about 2,000,000 cu. yd. of mate-

MATERIAL, DISLODGED BY GIANT, FLOWS TO MUCK PUMP FEEDING DAM rial, handled entirely through pumps. Only about 4 to 6 per cent of this material is moved in any way other than by using water as a vehicle. This small percentage represents the work done with Fresno scrapers in building up the dikes around the lake as the work advances.

The qualities considered in selecting material for the dam are that it shall contain at least 20 per cent of clay and silt, that the general character of the deposit be such that a hydraulic giant can cut it down into shape suitable for the pumps and that the deposit be conveniently located. Practically all the banks in the stream bed above the Fernando dam contain the necessary clay percentage, and the question has only been one of selecting the deposit nearest the dam which could be handled most readily.

The maximum distance which material has thus far been conveyed is about 3000 ft. Pumping has been continued with a single unit up to heads as high as 80 ft., but at this pressure it was found that the wear and slip in the runners exceeded the economical limit, and a maximum of about 50 ft. has been adopted, beyond which height it is considered advisable to install a booster. The maximum lift on the Fernando dam will be in a four-stage system that will total about 140 ft. when the dam reaches its highest level.

THE SAN FERNANDO HYDRAULIC-FILL DAM, LOOKING NORTHWEST

EARTH-HANDLING SYSTEM

In laying out the piping systems an effort is made to locate the pumps so that they can be fed through a natural channel on a 3 per cent grade from the bank where the hydraulic giant works. With this arrangement it is only necessary to undermine the material to be handled, after which it is conveyed by the water in open channel to the pump intake. Where the deposits were not found on the natural stream banks, pipes were laid to bring a sufficient volume of water for conveying the material into the nearest natural channel, down which it ran to the pumping station. The giants used had a 2-in. nozzle fed through a 4-in. pipe, and a pressure of 140 to 160 lb. per square inch was maintained by a centrifugal pump.

When the water was scarce none was allowed to waste unnecessarily. The overflow from the lake, which normally escapes through the bypass under the dam, was collected in a pool and pumped back to the bank where work was in progress, and by this means a flow of about 12 sec.-ft. was used continually with a total loss of about 1 sec.-ft. in leakage, seepage and evaporation. The flow of 12 sec.-ft. represents, roughly, the normal flow in the 14-in. pipes, each of which is calculated to handle approximately 4000 cu. yd. of material per 24-hr. run.

As taken up in the pump intake, the normal solid content of the water is calculated to be 1 cu. yd. per 10 cu. yd., and at this rate when the 50-ft. head was not exceeded the material handled at the Fernando dam was found to fix the life of manganese steel runners at about three months. The pumps used are standard Byron-Jackson units with 12-in. intake and 12-in. discharge, and are operated at 600 r.p.m. by belt connection to 2200-volt motors. The pipe is of 14-gage steel with slip joints and 10-gage butts and starters. This pipe cost 48¾ cents per foot in Los Angeles, and the wear on the Fernando work is such that its life averages 500,000 cu. yd. of material handled. The current for driving the motors is purchased at 1½ cents per kilowatt-hour, and, including all power and labor costs, as well as all overhead charges, Mr. Mulholland says that the total cost of placing the material in the dam is 7 cents per cubic yard.

SIX-MEN CREWS

One of the accompanying illustrations bears out the statement that this is a "lonesome job." A crew of 6 men for each shift is sufficient, except when diking up or moving plant, to operate two pipe systems that bring a total of 8000 cu. yd. of material into the dam in 24 hr. The closer view of the lake shore illustrates to good advantage the way in which the clay and silt are removed from the sand. Due to the washing out of all clay and silt particles in the course of its progress through the system, the material deposited near the discharge pipe is entirely sand and coarse material. Its porosity is shown by the fact that it is dry and firm enough to walk on within a few minutes after the discharge is shut off.

The condition desired at the center of the lake is just the opposite of this sandy, porous state, and on the occasion of a recent inspection of the dam an examination was made to determine the condition of the earth strata below the water. The maximum depth of water at the lake center is kept at from 16 in. to 2 ft. and here it was found that a 2-in. wooden pole could be thrust down vertically to a depth of 20 ft. At this depth the resistance of the compact earth layers prevented further penetration. When withdrawn the rod gave evidence of having been in fine silt and clay for the full embedded length of 18 ft.

Although very little seepage occurs through the dikes at the edge of the lake, lines of drain tile have been laid so that where this occurs it can be taken care of without washing the slopes, which are 2½ to 1. The upstream slope was paved with riprap up to about one-half the total height, and above this level a layer of concrete is to be placed as protection against wave action in the reservoir.

The dam is being built as part of the Los Angeles aqueduct, and was designed and is being constructed under the personal supervision of William Mulholland, chief engineer.

Maintaining Oiled Macadam Park Drives in Detroit

Method of Repairing Raveled Spots with Broken Stone and Oiled Granite Screenings

MORE than 280,000 sq. yd. of oiled macadam park drives and boulevards in Detroit are maintained in serviceable condition at small expense by the methods employed by the department of parks and boulevards of that city. These methods not only produce satisfactory results at slight cost, but also require a comparatively limited investment in plant.

The primary feature of the methods followed is to sprinkle all surfaces four or five times each season with an emulsion of oil and water. This emulsion is made up in the proportions of 100 gal. of oil, 600 gal. of water and 20 lb. of soap. An oil produced by the Standard Oil Company under specifications calling for about 40 per cent asphalt is employed. At a point near the center of the park and boulevard system a second-hand horizontal tubular boiler has been installed in a temporary building to furnish the steam necessary to emulsify the oil and water. Ordinary street-sprinkling carts are used in distributing the emulsion. The oil, water and soap are placed in these at the boiler plant. Live steam delivered from the latter to the tanks for about twenty minutes produces a complete emulsion. An application to the roadway surface consists of a single sprinkling.

Raveled spots and chuck holes are repaired with broken stone and oiled granite screenings. Where a spot in the macadam has merely begun to ravel it is cleaned and then rolled thoroughly with a 15-ton macadam roller. The spot is next covered with the oiled screenings to a depth depending on the character of the break. The screenings are rolled until the patch is level with the adjacent roadway surface. Formation of bad holes and ruts is thus avoided.

REPAIRING HOLES

On account of the exceptionally heavy automobile and motor-truck traffic on the drives maintained, particularly in the vicinity of large automobile factories, an untreated raveled spot quickly becomes a serious chuck-hole. In repairing the latter they are first filled a little more than flush with 2-in. broken stone. This filling is rolled heavily until it is flush with the street surface. Then the oiled granite screenings are added to a depth of about ½ in. and rolled until the patch edges conform to the abutting pavement. The screenings employed are from granite field stones crushed and roughly graded in size from pieces which will pass a ½-in. screen down to dust. The oil used is the same as in the emulsion made for sprinkling. Ordinarily 8 gal. of oil are used to the cubic yard of screenings.

Application of the oil to the screenings is made in a portable $\frac{1}{2}$-yd. heated Koehring mixer, located during the season in one position adjacent to the boiler used in making the emulsion. The screenings and oil are delivered at a nearby railroad switch. No attempt is made to protect the screenings from rain.

A foreman at 50 cents an hour and three laborers at 25 cents an hour operate the mixer. Two men wheel screenings to the machine and remove the output. A power-loading skip simplifies the charging. Prior to its addition to the mixer the oil is heated in an ordinary tar kettle sufficiently to make it liquid.

From five to eight minutes time is required to mix a batch, depending entirely on the amount of moisture in the screenings. Then heat is applied directly to the interior of the drum of the machine by a forced-draft oil burner. This is kept burning from the time the screenings are charged until dust begins to blow out of the drum. A temperature of 300 to 340 deg. Fahr. results in the drum. As soon as the dusting occurs the flame is shut off and the oil added through a quick-opening valve from a measuring tank on the machine.

TEMPORARY STORAGE

From the mixer the oiled screenings are wheeled to a temporary storage pile. The time they are left in this pile depends on the progress of the work. No attempt is made to place them hot. In fact, it has been found that the effectiveness of the oiled screenings is not reduced materially when they are stored for a considerable period. On account of the character of the work no attempt has been made to determine the unit cost of this method of maintenance. The total expense, however, is low, and ordinary water sprinkling scarcely could keep the drives in serviceable condition at any cost.

The mixer is in the middle of the second season without having required any repairs, except to the oil burner. The total quantity of screenings mixed by it amounts to about 1500 cu. yd. The maintenance methods employed were developed by F. A. Robinson, superintendent of parks and boulevards of Detroit, and are carried on under his direction.

CASH INVESTMENT of the railways in the last six years in road and equipment totals $4,010,385,303, according to the Bureau of Railway Economics.

Completion of San Fernando Siphon, Los Angeles

Steel Pipe That Forms the Connecting Link between the Aqueduct and the City's Present Distribution System

By WILLIAM W. HURLBUT
Engineering Department, Bureau of Water Works and Supply, Los Angeles

THE Los Angeles city trunk line, which is the connecting link between the Los Angeles aqueduct and the present water system of Los Angeles, extends from the south portal of tunnel 108 of the aqueduct on the north side of the San Fernando Valley to Fourth Street and Western Avenue, Los Angeles, at which point the connection with the 30-in. main of the present system is made, a distance of 25 miles from the end of the aqueduct.

In October, 1911, bonds to the amount of $1,500,000 were voted to construct this trunk line, which consists of the elements shown in Table 1.

The San Fernando siphon which extends from the Lower San Fernando reservoir to the Franklin tunnel is the principal feature of the city trunk line. The steel for this siphon is listed in Table 2.

There are in addition 540.16 ft. of 72-in. reinforced concrete pipe from the tower through the dam to a connection with the steel pipe.

CONTRACT PRICES

In October, 1912, bids were asked for furnishing steel and rivets for the siphon. Bids were called for on separate items, plates and rivets on board cars, and plates fabricated in four-ring sections and delivered at the trench. The Riter-Conley Manufacturing Company secured the contract for the 68, 66 and 64-in. diameter plates, consisting of 4249 tons, for the sum of $141,065 on board cars at Leetsdale, Pa., shipped knocked down, the city fabricating the plates along the trench and placing same. The Lacy Manufacturing Company, of Los Angeles, secured the 72 and 62-in. diameter contract for plates, which were delivered to the city in four-ring sections, 24 ft. in length, along the trench, fabricated. The city placed the pipe and riveted the circumferential seams in the trench. The tonnage on this portion amounted to 4010 at a cost of $281,700. The Riter-Conley Manufacturing Company's steel cost $1.659 per 100 lb. at Leetsdale, Pa. The Lacy Manufacturing Company's steel cost $3.512 per 100 lb. at the trench.

The top of the pipe across the valley laps on an average of 3 ft. below the surface. Two model 20 Marion steam shovels were used for trenching. The soil was sandy loam, easy material to excavate and handle, and required no timbering. The reason for the pipe being placed this depth is that the San Fernando Valley is wholly an agricultural district.

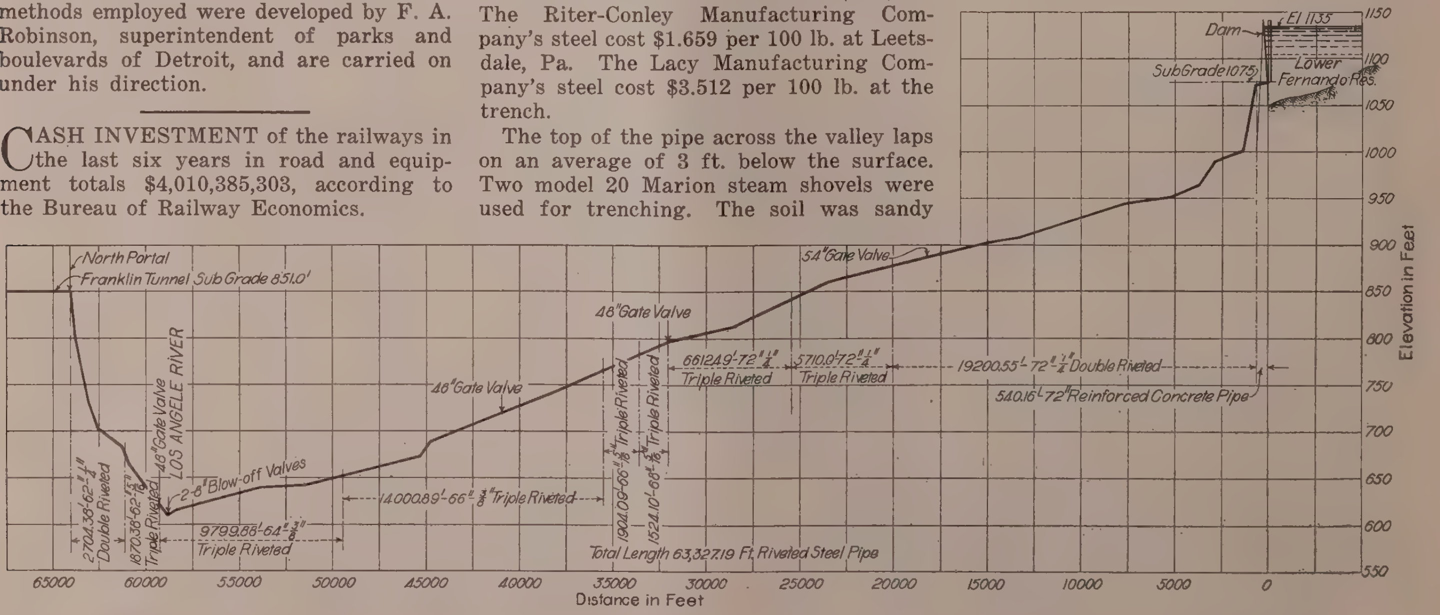
Construction was started at two points in the valley, one camp being established in the north side on Aug. 13, 1913, and one on the south side July 13, 1913. The work was completed April 27, 1914. On this date water was admitted gradually and the pipe was tested; on May 1 water was turned into the Los Angeles river through two 8-in. blow-off valves at the lowest point on the line. This water finds its way down the course of the river to the headworks of the present water system, at which point it is diverted into the distributing system of the city.

As the work on the 40-in. Cahuenga siphon from Franklin canyon into the city is still under construction and will not be completed for several weeks, thereby making direct connection to the city mains, this method of by-passing the water at the river crossing to the present headworks allows the means of additional water reaching the city until such time as the direct connection is made.

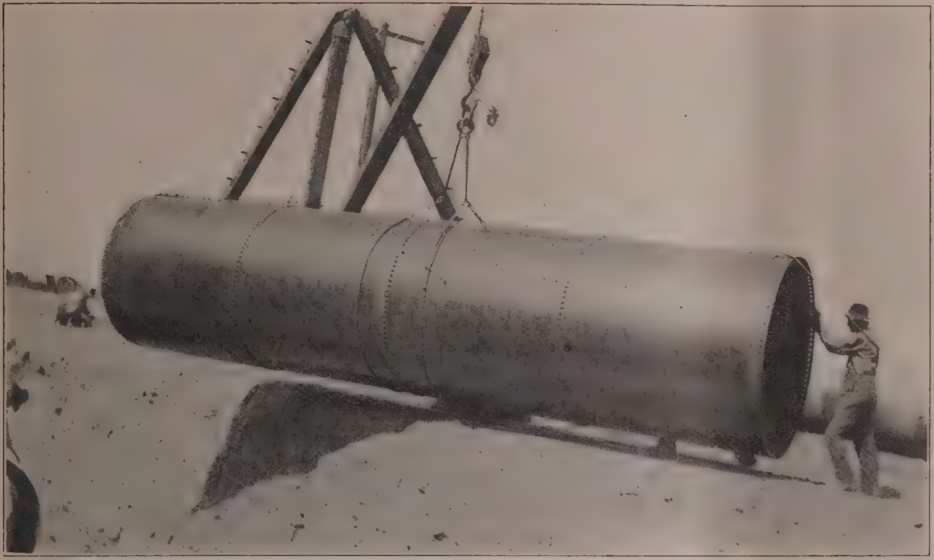
Where the San Fernando siphon crosses the Los Angeles River on the extreme south side of the valley it is carried on concrete piers, 30 ft. center to center. At this point during the recent flood of February and March the pipe was subjected to a most severe test, the flood waters being 2 ft. over the top of the pipe. Although construction was retarded no damage was done.

The pipe is coated with three coats of gas tar paint both inside and outside.

The Franklin tunnel has a slope of 0.001 and a capacity of 12,000 miner's inches. The driving of this tunnel through sandstone, shale and wet swelling ground was difficult. The tunnel is timbered through-



PROFILE OF SAN FERNANDO SIPHON, SHOWING THICKNESSES OF PIPE AND HEADS OF WATER WHICH IT WITHSTANDS



PLACING FOUR-RING SECTION OF SAN FERNANDO STEEL PIPE SIPHON

out its entire length and is lined with 10 in. of concrete.

The reason for entering the city to the extreme west is due to the rapid growth in that direction, and the excessive head on a line located to the east of the San Fernando Valley, in order to bring the supply in on the north. A feature of note in the open conduit is the high velocities; they vary from 15 to 25 ft. per second.

The capacity of the open conduit is 20,000 miner's inches—the capacity of the aqueduct—while the capacity of the covered conduit is 15,000 miner's inches; the other 5000 miner's inches are by-passed into the upper Fernando reservoir.

The covered conduit connects direct to the Fernando siphon at the upper tower of the Lower Fernando reservoir at El. 1075 ft. There is also an overflow weir located on the covered section designed to by-pass the full supply into the lower reservoir. The tower is also constructed so as to allow the water to flow into the reservoir or to be taken out directly into the siphon.

TABLE 1—ELEMENTS OF CITY TRUNK LINE

Conduit	10,000	ft.
San Fernando siphon	63,327	ft. riv. steel pipe
Franklin tunnel	3,766	ft.
Lower Franklin reservoir with capacity of	1,100	acre-ft.
Cahuenga siphon	35,130	ft. riv. steel pipe 40 in. in diameter

The sub-grade or bottom of pipe at the tower is at El. 1075 ft., while the elevation of high water in the reservoir is 1135 ft., giving an effective head of 140 ft. on the siphon at the north end. The bottom of pipe where it enters Franklin tunnel is at El. 851 ft.

The capacity of the siphon at the intake is 11,000 miner's inches, while the capacity at the south end is 7500 miner's inches. The difference in capacity is due to the water allowed territory adjacent to the main in the San Fernando Valley. The siphon is designed for full supply plus 50 per cent, distributed as follows: 2000 miner's inches are allowed for the city within its present boundaries; 2000 inches for territory west of the present boundary, and 1000 inches to the south of the present city boundary—or a total of 5000 inches plus 2500 inches or 50 per cent, making a total of 7500 inches.

TABLE 2—STEEL FOR SAN FERNANDO SIPHON

Length in Feet	Diameter, Inches	Thickness, Inches	Riveting Longitudinal Lap Joint
19,200.55	72	¼	⅝-in. double riveted
5,710.00	72	¼	⅝-in. triple riveted
6,612.49	72	5/16	⅝-in. triple riveted
1,524.10	68	5/16	⅝-in. triple riveted
1,904.09	66	5/16	⅝-in. triple riveted
14,000.89	66	⅜	¾-in. triple riveted
9,799.88	64	⅜	¾-in. triple riveted
1,870.81	62	5/16	⅝-in. triple riveted
2,704.38	62	¼	⅝-in. double riveted

The high velocity of 9 ft. per second is reached in this siphon, the average slope being 0.0041 and a maximum head of 525 ft. The steel design is for 15,000 lb. per square inch on the net section with a factor of safety of four.

The pipe is fitted with five emergency control valves. They are Rensselaer valves, the next commercial size larger than one-half the area of the pipe, and are of the type that lie on their side. All of them set in reinforced concrete housing. There is one 54-in. valve weighing 18 tons having a 12-in. by-pass; three 48-in. valves weighing 15 tons each with an 8-in. by-pass, and one 36-in. valve weighing 12 tons with an 8-in. by-pass. In addition to the above control valves the pipe is fitted every one-half mile with a 6-in. Rensselaer gate valve for service.

The completion of this link of the city trunk line insures a permanent and ample water supply for the city and removes for all time the water shortage such as Los Angeles has experienced during the hot summer months for the past few years. It is necessary to install pressure reducers on the Cahuenga siphon, the water being delivered into the city's mains at a maximum pressure of 200 ft. of head and a minimum of 100 ft. of head.

The presence of the water at this time in the city mains has made good the prediction of William Mulholland, chief engineer of the Los Angeles aqueduct and Bureau of Waterworks.

A RECORD YEAR IN TIMBER PRESERVATION—In the year 1913, according to a report recently issued by the American Wood Preservers' Association in co-operation with the U. S Forest Service, ninety-three wood-preserving plants consumed more than 108,000,000 gal. of creosote oil, 26,000,000 lb. of dry zinc chloride and nearly 4,000,000 gal. of other liquid preservatives. With these the plants treated more than 153,000,000 cu. ft. of timber, or about 23 per cent. more than in 1912.

Cost of Hauling in Chicago

Comparison of Results Obtained by Horses and by Motor Trucks

DETAILED comparisons of hauling by teams and motors indicate that by the former it costs 17¾ cents per ton-mile and by motor trucks 11¼ cents. These figures and the following notes are from a preliminary report of the Chicago Municipal Markets Commission appointed by Mayor Harrison to make a comprehensive study on the municipal markets and other agencies tending to bring producer and consumer into closer contact.

Of the three methods of transportation it is estimated that the relative cost under present conditions is 0.6 mill per ton-mile for water, 4 mills per ton-mile for railway and 50 cents per ton-mile for wagon transportation. Delivery of farm products from the railroad freight stations in Chicago is carried on by teaming, and in nearly every instance requires long, tiresome team haul through the loop district. The relatively small area in Chicago in which team hauling of food products, to and fro, is carried on lies between Twelfth Street on the south, Chicago Avenue on the north, and the river on the west. It is less than 2 miles long and less than 1 mile wide. It is estimated that in this area teams now haul daily 150,000 tons of freight. The team traffic of New York City is estimated at approximately 70,000 tons per day; that of Boston, 55,000 tons per day, and that of Philadelphia, 68,000 tons per day.

WHAT 1000 TEAMS MUST EARN

Approximately 1000 teams in the city of Chicago are engaged in the carrying of food products, exclusive of the delivery-wagon service of the retailers, and in order to be profitable to their owners they are required to earn about $6 per day for single teams and $8 per day for double teams. These wagons, as a rule, bear the wholesale merchants' names, but are owned by teaming concerns which rent these wagons for the exclusive use of firms at a specified sum per week. They are under the direction and control of the house employing them, but the maintenance and other expenses are borne by the team owner. Because of the congestion existing in the streets of the central business district, and the consequent inadequacy of the streets to afford free passage to vehicles, team hauling is decidedly wasteful. The average wagon or truck spends about one-third of its time actively hauling commodities on the street and two-thirds of its time in waiting, loading, unloading and in delays to traffic. The average cost of deliveries by department stores, grocery stores and meat markets is shown to be approximately 8 cents by motor and 16 cents by horse. The analysis shows that the average cost of operating motor trucks and delivery wagons, embracing both gasoline and electric type of machines, is $10.97 a day, inclusive of all items of operation and maintenance, such as driver, garage, interest and depreciation. The average cost of doing equivalent work with horses is $16.75 a day, which represents the expenses of from two to three wagons with drivers.

Among the eleven recommendations was one to utilize trolley lines for freight service during non-rush hours, to give the producer direct access to the markets of the city over existing street railway lines and interurban tracks.

Contractors and Sureties

Three Recent Decisions by the U. S. Supreme Court on the Obligations They Must Assume in Case of Stoppage of Work

By GEORGE A. KING
Of the Bar of the Court of Claims, Washington, D. C.

THREE decisions of great importance have recently been given by the Supreme Court of the United States on the liability of contractors and their sureties in case of stoppage of work on contract, either by failure of the contractor or by termination of operations under a contract by virtue of a power reserved to some officer of the Government by provision in the contract.

The former of these cases was that of Rudolph Axman under his contract for dredging San Pablo Bay, California, the American Bonding Company of Baltimore being the surety on the bond. Axman's contract required him to excavate a channel and to deposit the spoil within the lines drawn at such places as might be designated by the engineer officer in charge within certain limits, and to impound the material behind bulkheads or dikes of suitable construction. The Government reserved the right to annul the contract and provided in that case that any excess of cost incurred by the United States in completing the work should be charged and paid by the contractor and his surety. The Government annulled the contract under this provision and relet the contract with a provision, however, for the depositing of the spoil in deep water.

THE PRICE PAID

The Government paid a higher price under the new contract than that stipulated in the old and sued the original contractor and surety company for the difference in cost. On the trial of the case the Government offered evidence of witnesses to show that no more than a fair price had been paid the new contractor, and also that it cost no more to deposit and dump the spoil beyond the bulkheads provided for in the original contract than in deep water as provided for in the new one. The Supreme Court held that the work provided for in the second contract was materially different from that called for by the first and that thus being different it could not be used as a basis for charging the excess of cost to the original contractor. It said in an opinion by Mr. Justice Day:

"It therefore follows that not only was Axman to dredge the channel as required by the contract, but he was to deposit the spoil as therein specified. Dredging the channel would not be enough to show performance of his contract, unless he complied with the other material requirement as to the deposit of the spoil. The new contract contained a different stipulation as to the dumping of the spoil. Upon the showing made in this case we think the change in the place of dumping the spoil was very material, and could not be made consistently with the terms of the agreement under which Axman undertook to perform the work or be liable as stipulated in paragraph 4."

This conclusion was reached: "We are clearly of the opinion in this case that the work done under the second contract was not the work which the first contractor had agreed to perform. While it is true it accomplished the dredging of the channel in the same bay, it did this with a disposition of the spoil not permitted under the first contract and in a material matter was different from the contract first entered upon."

Thus neither the contractor nor the surety was held liable for the difference in cost.

LIABILITY OF SURETY

Altogether different considerations were held to govern the liability of a surety company to persons supplying materials to contractors for public works of the United States or the District of Columbia. A contract was made by the District Government for the erection of a school building at Eleventh and Harvard Streets, to front on Eleventh Street. Bond was given, as required by the act of Congress, that the contractor should make prompt payment to all persons supplying him with labor or materials. Later, without the consent of the surety, the building was changed so as to front on Harvard Street, involving the contractor in greatly increased expense, particularly for excavation. A subcontractor who had supplied stone sued the surety company on the bond, and the defense relied upon these changes in the contract obligations as discharging the surety. The opinion of the Supreme Court was delivered by Mr. Justice Pitney, the case being entitled Equitable Surety Company vs. United States, use of McMillan. It holds that as the material man had no hand in the changes it would be unjust to deprive him of the protection of the bond, so long as the materials supplied were such as were contemplated by the original contract. The conclusion is thus convincingly stated:

"In the light of the statute, the surety becomes bound for the performance of the work by the principal in accordance with the stipulations of the contract, and for the prompt payment of the sums due to all persons supplying labor and material in the prosecution of the work provided for in the contract.

"What would be the result of a change not contemplated in the original contract, as between the District of Columbia, consenting to the change, and the surety company, not consenting thereto is a question not now before us and respecting which we express no opinion. But with respect to obligations incurred by the contractor to laborers and materialmen, at least so far as their labor and materials are supplied in accordance with the original contract, it is obvious, we think, that a construction which would discharge the surety because of any change to which the laborers and materialmen were not parties would defeat the principal object that Congress had in view in enacting the statute. If the change were so great as to amount to an abandonment of the contract and the substitution of a substantially different one, so that persons supplying labor and materials would necessarily be charged with notice of such abandonment, a different question would be presented. But, in the case of such a change as was here made—a mere change of position and location of the building without affecting its general character, involving changes in grading, but having nothing to do with the furnishing of the materials upon which the action is based, it seems to us that the responsibility of the surety to the materialmen remains unaffected."

Elsewhere in the opinion it appears that a number of the lower Federal courts have already given the same construction to these bonds, so that this decision is not so much the enunciation of a new rule as it is the confirmation of one already established.

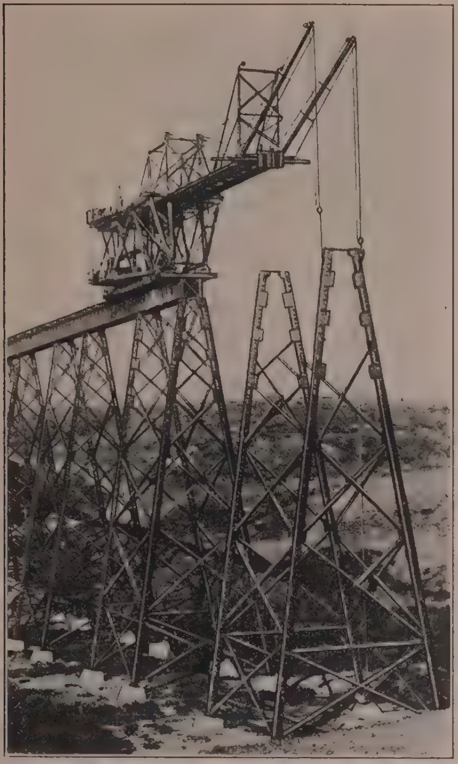
The last case was that of the Stone, Sand & Gravel Company and its surety, the American Surety Company of New York, on a contract made on the old form used in the Engineering Department of the Army up to about twelve years ago, in which it was "provided that if the contractor fails to commence with the performance of the work on the day specified herein, or shall, in the judgment of the engineer in charge fail to prosecute faithfully and diligently the work in accordance with the specifications and requirements of this contract, then, in either case * * * the engineer in charge shall have power, with the sanction of the Chief of Engineers, to annul this contract by giving notice in writing to that effect * * * and upon the giving of such notice all money or reserved percentages due or to become due * * * by reason of this contract shall be and become forfeited to the United States * * *. The engineer in charge is thereupon authorized, if an immediate performance of the work, 'be, in his opinion, required by the public exigency, to proceed to provide for the same * * *,' as prescribed in section 3709, Revised Statutes."

PRELIMINARY EXPENDITURES LOST

The contracting company made large expenditures in an effort to get ready, but found that the contract was larger than its financial capacity would permit it to carry out and the court said that the "United States was plainly within its contract right in putting it off the job and in reletting the work."

The court, following its decision in the O'Brien case rendered some years ago, held that the clause quoted limited the right of the Government on annulment to the forfeiture of the reserved percentages, because in case of forfeiture before the work was begun there were no such reserved percentages. The court in an opinion by Mr. Justice Lurton put its conclusions on the following grounds:

"Both parties elected to deal with the matter by express stipulation and that should be and is the end of it. In such a situation there would be no justice in straining the contract for a construction which would limit its application to cases where the right of annulment would not exist without it. This contract was prepared in advance of the bidding by the United States. The bidder was required to bid with strict reference to its terms. One term was that the work should begin with a plant and force of definite capacity on or before a particular day. Another was that if this term was not complied with the United States might annul the contract and that as a consequence of such annulment all money earned under it should be forfeited. This forfeiture is not made dependent upon the existence of any actual damage. Thus damages were by stipulation liquidated. That such damages may be in this instance



ERECTING TOWER WITH TRAVELER DERRICKS

inadequate may be true, but the fact affords no ground for frittering away the agreement by fanciful distinctions which never entered the head of either party to it.

"The plain purpose was to obtain for the United States the right to take the contract from a bidder who should break his agreement at its threshold and let the work to another, possibly for a better price. At any rate the right to annul for a breach in respect of the time of beginning was a valuable right, and for it the Government stipulated and liquidated the damages in the event of its exercise. The contractor would not only lose his contract, but also would forfeit everything due him. The agreement settled the right and all the consequences of its exercise."

The conclusion was reached: "The right to annul is expressly conferred by clause A for a failure to begin on the stipulated day. The United States resorted to that clause for its authority and pursued the procedure therein pointed out. It is plainly bound by the limitation of damages therein prescribed. For the error in not so confining the recovery, the judgment is reversed and a new trial awarded."

These decisions are but illustrations of the old rule of law that where the parties have agreed to a certain mode of estimating damages in case of the failure of the contractor to comply with his obligations, the court will not substitute another and different mode of estimating those damages. They also illustrate the law of suretyship that the obligation of a surety rests on the terms of his contract and that the court will not except or enlarge it by liberality of construction.

A MINIATURE of the Panama Canal, built on a scale of 6½ ft. to the mile, is to be operated at San Diego, Cal., during the exposition next year. A contract for constructing the model has been awarded. The cost is estimated at no less than $250,000.

Indian Creek Viaduct

High and Long Plate-Girder Structure with 46½-Foot Steel Towers and 69¾-Foot Connecting Spans

THE character of standard steel viaduct construction developed on the bridge work of several thousands of miles of the Chicago, Milwaukee & St. Paul Railway system is illustrated by the single-track viaduct across Indian Creek, Montana, on the Lewistown Great Falls line. This structure has towers braced by diagonal instead of horizontal struts, and has long-span plate-girders with special compression flanges.

The viaduct is about 1305 ft. long and 150 ft. high from base of rail to top of lowest pedestal. It has ten steel towers 46½ ft. long, one single bent, ten 59-ft. 9-in. connecting spans and two end spans of about the same length. The superstructure is of simple standard design developed by the railway company and conforms in general to advanced American railroad bridge practice. Details of the top chords and web splices for the long girders and of the columns are illustrated to show some special features.

The towers are made of pairs of vertical bents with battered columns X-braced transversely in stories from 10 to 31 ft. high. There are no horizontal transverse struts, excepting one at the top of the first story which is supported at the center point by a vertical hanger from the intersection of the diagonals above. The bents are X-braced longitudinally in corresponding stories and have no horizontal longitudinal struts, except a bottom one where the pedestals of one bent are considerably higher than those of the other bent in the same tower.

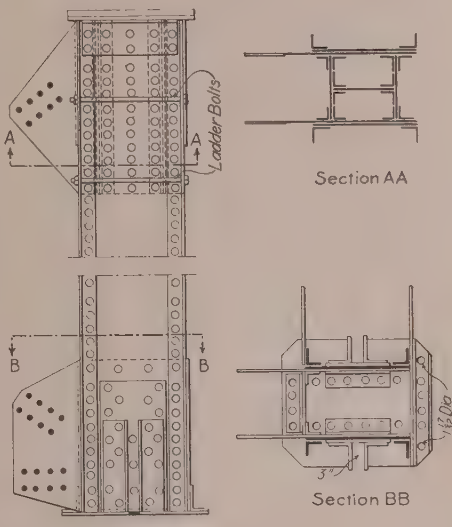
DESIGN

The viaduct is designed in accordance with the 1910 specifications of the American Railway Engineering and Maintenance-of-Way Association, for Cooper's E-60 live load on a ballasted concrete floor. The columns are designed for maximum unit stresses determined by the following three cases: (1) Using the formula 1600 — 70 L/R without any coefficient for dead load, plus live load, plus impact; (2) the same formula with a coefficient of 1.2 for the same load plus wind or traction; (3) the same formula with a coefficient 1.3 for the same load plus wind loads, plus traction.

Column stresses are figured on the assumption that in one system both longitudinal and transverse braces take stress simultaneously. The longitudinal and transverse braces are designed on the assumption that both systems are simultaneously stressed. The maximum column stress was computed as 1,120,000 lb., requiring a cross-sectional area of 66.2 sq. in., for which 68 sq. in. was actually provided.

In the 69-ft. 9-in. girders the maximum loads per linear foot were assumed to be a locomotive live load of 4235 lb., impact of 3450 lb., dead load of floor 2200 lb., dead load of metal 540 lb., total, 10,425 lb. The maximum moment and maximum shear were respectively 74,400,000 in.-lb. and 396,000 lb.

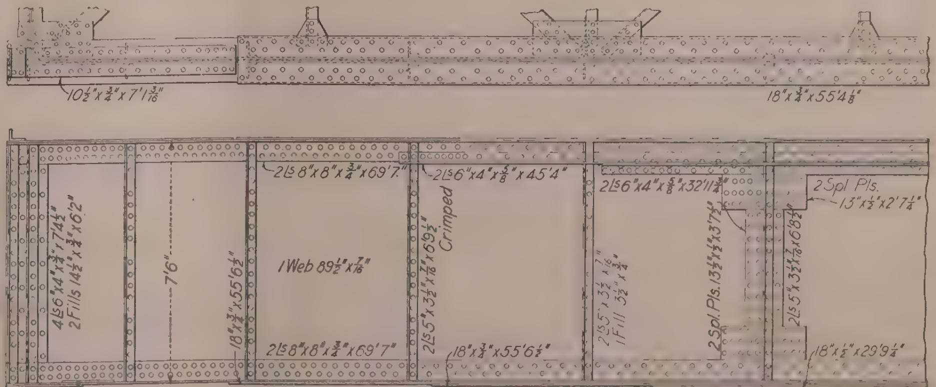
The T-shape bottom flange has maximum gross and net areas of 57.76 and 49.38 sq. in. respectively. The top flange is not a duplicate of the bottom flange, but has in the center of the girder an additional pair of reversed angles, giving it an H shape and increasing the efficiency as a compression member. Where the moment is greatest the extra angles are reinforced. The gross sectional area is 59.82 sq. in. One-eighth of the area of the 90 x 7/16-in. web is assumed to be efficient for flange stresses. In the top flanges of the 49½-ft. girders the 6 x 4-in. reinforcement angles in the middle are omitted and the cover-plate is only 10½ in. wide.



DETAILS OF TOWER COLUMN

The transverse and longitudinal braces are all field-riveted between jaw-plates shop-riveted to the flanges and webs of the columns. The intermediate flange cover-plates are all provided with pairs of 3 x 6-in. round-end hand holes, giving access to the interior of the columns for painting and cleaning.

Pairs of vertical distributing angles are



GIRDER WITH H-SHAPE COMPRESSION FLANGE REINFORCED IN CENTER

U OF I
LIBRARY

riveted to the column webs at the foot to provide bearing on their upper ends for the anchor bolts which pass between them and through slots cut in the edges of the base plates, instead of having full holes there. The top of the column is reinforced by a short transverse diaphragm distributing the load from the top plate through the webs of the channels.

The viaduct contains about 1800 tons of structural steel erected by the railway company by a wooden cantilever traveler having a pair of derrick booms and braced masts seated on the end of a long guyed overhang. The structure was designed by the engineering department of the Chicago, Milwaukee & St. Paul Railway, of which C. F. Loweth is chief engineer and J. H. Prior, engineer of design.

Federal Railroad Evaluation

Developments of the Last Two Months as Gleaned from Circulars Issued by the Railroads and the Government

DEVELOPMENTS of the Federal evaluation of the railroads for the first four months of this year were outlined in a circular issued some time ago by Thomas W. Hulme, general secretary of the Presidents' Conference Committee. This was abstracted in the Engineering Record of May 30, page 630. Further progress is reported in another circular issued by Mr. Hulme and in one issued by the Division of Valuation of the Interstate Commerce Commission.

At the engineering conference the railroad committee recommended certain changes in the Government's tentative instructions to roadway and track field parties. One was to provide for the noting under each of the three classes of material under "Grading" specific descriptions to aid in fixing prices. Another was to require the assistant field engineer to record all facts bearing on the condition of the property, and not require him to record the "condition per cent." A third was the addition of the following under "Special Information": "Where the attention of the Government representative is called by the railroad representative to facts essential in his opinion to proper valuation of physical property, note of such claimed facts, together with the Government representative's view of their accuracy, if not agreed to, shall in all cases be recorded."

CO-OPERATION AGREEMENT

Valuation Circular 1, issued by the Director of Valuation under date of May 1, has just been given out. Attached to it is an agreement form intended to prevent duplication of work and secure correct results. The agreement provides that copies of all field notes of chaining and cross-sectioning parties will be delivered to the railroad, that the railroad will point out in writing within thirty days all alleged errors and omissions, that all notes not so objected to within thirty days shall be accepted as correct unless the errors are palpable, and that if the carrier claims anything which should be included in the survey but is not open to visual observation and measurement it shall either definitely indicate in writing to the commission before the survey begins the nature, locality and extent of such property, or shall definitely point out the same at the time of the survey, producing any maps or record evidence substantiating the claim. The Government desires that its calculation of quantities be examined and checked by the carrier, and the engineering committee, counsel and general secretary join in recommending the plan of co-operation proposed.

The circular states that all roads believing their maps and profiles satisfactory to the Government should assemble them at points for convenient inspection and should notify the Government as soon as the maps are ready. All carriers with annual gross incomes of $100,000 or more are also instructed to prepare a list of their lands at once. Roads with annual gross incomes of less than $100,000 are excused from doing this for the time being.

Valuation Orders 2, 3 and 4 have just been issued by the Interstate Commerce Commission. Orders 2 and 4 are brief, pertaining respectively to abandoned property and to inventory of materials and supplies. The former requires the filing by each steam railroad, on or before Feb. 1, 1915, of a detailed statement of all property abandoned before June 30, 1914. The latter stipulates that each road must make an inventory of materials and supplies as of June 30 of each year.

ADDITIONS AND BETTERMENTS

Order 3 is a bound pamphlet of eight pages treating of additions and betterments. It accords with the developments in the discussion at the accounting conference June 8. It calls for a numbered "authority" setting forth clearly the general character and location, quantities and amount involved in each extension, improvement or change. The records shall be kept by jobs, separately by owners, and also separately by States and Territories. Reports of authorized jobs must be made within six months of their completion, itemized according to the commission's classification of primary accounts, and summarized by fiscal years where the work extended over two or more fiscal years. Summaries only of uncompleted work are required. Maps, profiles, plans or diagrams as needed must be furnished in support of these reports.

These reports are to be made for each fiscal year ending June 30, the first one being dated June 30, 1915, for carriers whose property is inventoried as of June 30, 1914, and the first June 30 following the inventory date of all other roads. The roads not inventoried June 30, 1914, must, however, so keep their accounts as to permit reports in accordance with the orders of the commission.

The general secretary has issued a communication with reference to the importance of an investigation of hidden and extraordinary quantities, costs and special features of construction not visible on a field inspection of the property.

The land, accounting and engineering committees will probably hold a conference early in August, but it is not expected that there will be any more formal conferences with the Government until some time after Oct. 1.

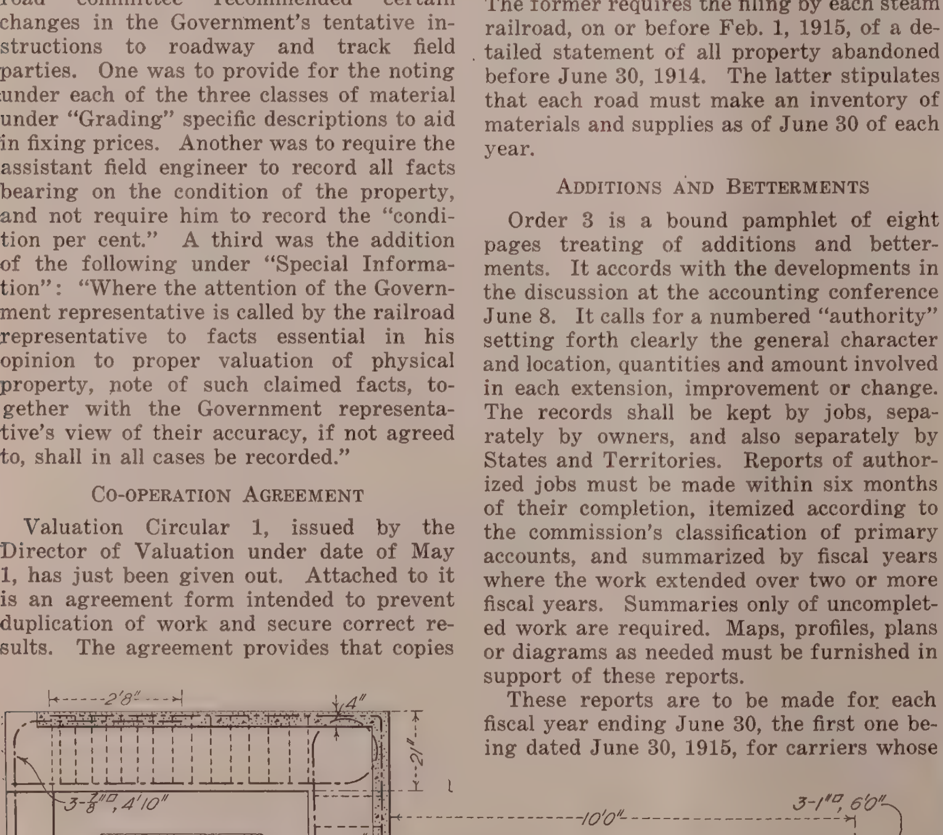
European Railroad Gages

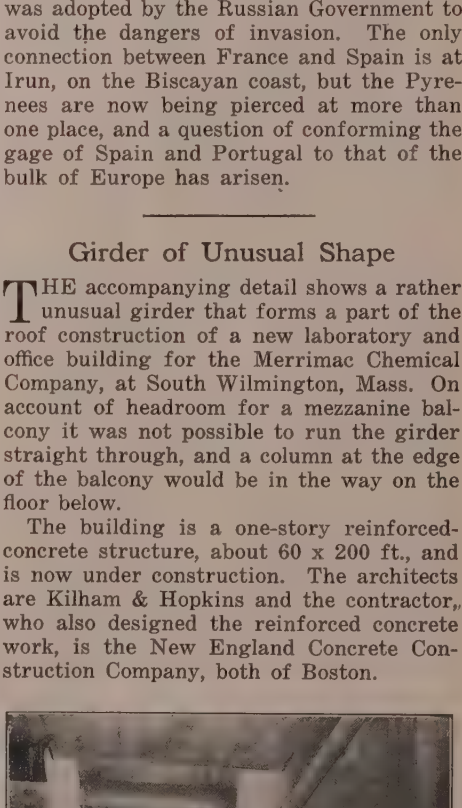
THERE are several railway gages in Europe, but in the United States and Canada it is possible for a truck to travel from Prince Rupert to New Orleans, and from Quebec to San Francisco without hindrance. This was accomplished at great expense some twenty or thirty years ago. In Europe the bulk of the mileage is the standard 4 ft. 8½-in. gage. There are, however, some other gages, especially the meter gage in France, Belgium, Italy, Spain and Portugal. The most important exceptions are in Spain and Portugal, where they have nearly 10,000 miles of the 5 ft. 6-in. gage, and in Russia and Finland, where there are 30,000 miles of the 5-ft. gage. This 3½-in. difference from the standard was adopted by the Russian Government to avoid the dangers of invasion. The only connection between France and Spain is at Irun, on the Biscayan coast, but the Pyrenees are now being pierced at more than one place, and a question of conforming the gage of Spain and Portugal to that of the bulk of Europe has arisen.

Girder of Unusual Shape

THE accompanying detail shows a rather unusual girder that forms a part of the roof construction of a new laboratory and office building for the Merrimac Chemical Company, at South Wilmington, Mass. On account of headroom for a mezzanine balcony it was not possible to run the girder straight through, and a column at the edge of the balcony would be in the way on the floor below.

The building is a one-story reinforced-concrete structure, about 60 x 200 ft., and is now under construction. The architects are Kilham & Hopkins and the contractor, who also designed the reinforced concrete work, is the New England Concrete Construction Company, both of Boston.



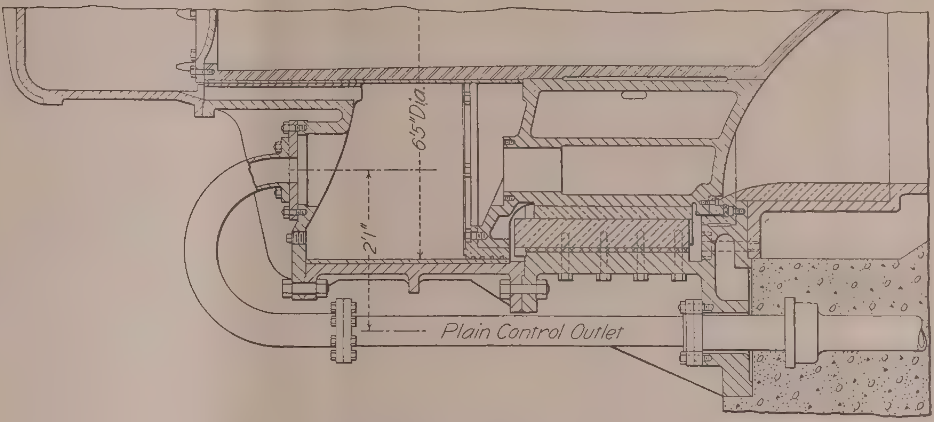


REINFORCEMENT IN CONCRETE GIRDER OF UNUSUAL SHAPE AND APPEARANCE OF MEMBER AS CONSTRUCTED

Large Balanced Valves for Reservoir Outlets

Regulating Discharge through Arrowrock Dam on Boise Project in Idaho by Twenty 52-Inch Horizontal Submerged Conduits

TWENTY balanced 58-in. valves will be used for regulating the discharge through the 52-in. outlets in the Arrowrock dam on the Boise Irrigation project in Idaho. They will be installed with their axes in horizontal planes and will be submerged in the reservoir, thus being practically inaccessible. The Arrowrock dam was described in the Engineering Record of Feb. 22, 1913, page 214, and the location of these valves was shown on the accompanying drawings. The valves will be set in two tiers of ten each. The lower valves will be under approximately 200 ft. maximum head and the upper ones under about 100 ft.



DETAIL OF OUTLET VALVE PROVIDED WITH PLAIN CONTROL

DESCRIPTION

The valves shown in the illustration herewith are hydraulically balanced needle valves, each consisting of a cylindrical semi-steel structure having a circumferential inlet and a central discharge. Within the cylinder, which is closed at the outer end, slides a piston, the inner end of which forms a needle operating to regulate the amount of water discharged and closing similar to a check valve. Bronze V guides keep the needle in perfect alignment with the axis of the cylinder, so that it may move freely without binding. The removal of the cylinder head allows the removal of the main piston or needle. The piston is provided with water-packing grooves to minimize the leakage between the piston and the lining of the cylinder.

Two methods of control of the piston are to be used—plain control for opening and closing the valve to its full capacity only and a positive control for giving fractional openings. It is opened and closed by the regulation of the pressure of water behind the main piston, the pressure being supplied by the restricted leak past the piston and relieved through a drain or control pipe leading out from the cylinder head. To open the plain controlled valve to its full capacity the pressure upon the piston is reduced by opening the outlet of the control pipe until the valve begins to move. It will then continue to move until completely open. To close the valve, the outlet of the control pipe from the cylinder is closed and pressure applied above the reservoir pressure from an external source for an instant to start the piston. When once started the valve will slowly close itself, the pressure being supplied by leakage around the piston.

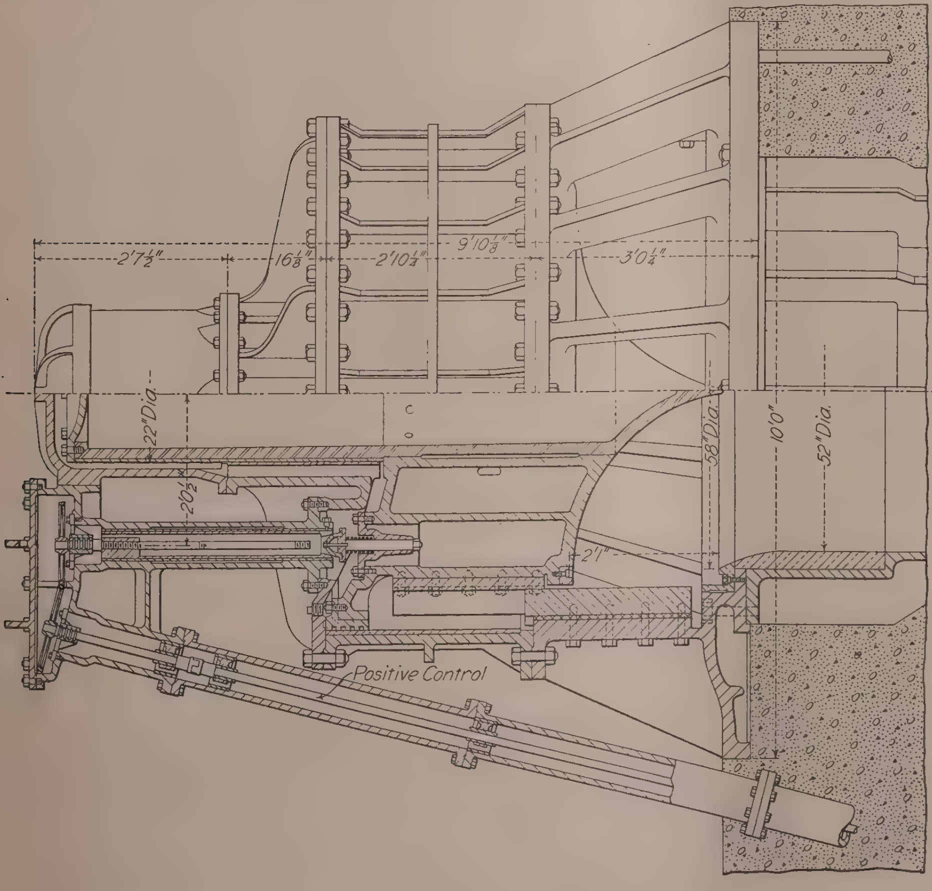
To operate the positive control for opening the valve, the movable sleeve constituting the controlling element is withdrawn from the conical seat adapted to close the bore of this sleeve, thus allowing the water to escape through the sleeve and out through the waste pipe. The valve piston will follow this sleeve, maintaining, automatically, sufficient area between the end of the sleeve and the valve seat to control the pressure on the piston to the amount necessary to balance the valve in any position against the static or reaction pressure acting against the discharge face of the needle and piston. Forcing the sleeve against the seat will stop the flow of control water, cause the pressure to build up behind the piston and close the valve. The indicator will show the position of the valve at any instant. The valve will be operated from a chamber within the dam underneath the discharge pipes through the medium of cranks, shafts and gearings. The valves with plain control are operated from the same chamber by means of a small valve in the control pipe. There will be three positive controlled valves in each.

It is stated that the valves in the lower tier will be installed during January, 1915, and the valves in the upper tier during the following July.

TESTS

Before placing the contract for these valves a life test for endurance was made on a full-size model of the sleeve-position control. The device was tested with slightly muddy water and connected with an automatically reversing motor, which operated it to represent fifty years of life in actual service, so far as the number of operations is concerned. The water carried silt suspended by the rapid motion of the water, while the valves as they will be installed will operate against the face of the dam with miles of quiet water upstream. The test continued for several weeks, the motor opening and closing the valve about once in four minutes. Indications are, according to O. H. Ensign, chief electrical engineer, who has charge of the valve design, that the life of this part of the installation is almost indeterminable.

This work is in the Idaho Division of the U. S. Reclamation Service. F. E. Weymouth is supervising engineer of the division and C. H. Paul, construction engineer of the Arrowrock Dam.



58 INCH BALANCED VALVE WITH POSITIVE CONTROL FOR RESERVOIR OUTLET

ADDITIONAL WATERWORKS FOR HONG KONG are being constructed. The main features are a dam 160 ft. high, to impound 1,500,000,000 gal. and two sets of pumping machinery with a capacity of 2,000,000 gal. per day. The project will be completed in 1917.

Cost of Cleaning and Repairing Weston Aqueduct

Gasoline Power Sprayer Discharged Water Under 200 Pounds Pressure Against Interior Surface

THE Weston Aqueduct, which delivers water from the Sudbury reservoir to the metropolitan district in the vicinity of Boston, was cleaned up and repaired during 1913. A section of the conduit, 5660 ft. long, between the terminal chamber and the Weston reservoir, was out of service from March 18 to April 10 while the work was in progress. The following description of the methods employed is from the annual report of Dexter Brackett, chief engineer of the Metropolitan Water Board:

Two gangs of men were employed, one beginning at each end of the section to be cleaned and working toward each other. One gang used water and hand brooms in cleaning the sides and top of the aqueduct, a wagon with a tank body being used when cleaning the top. The second gang made use of a gasoline power sprayer by which water under 200 lb. pressure was discharged against the interior surface of the aqueduct. This method proved more efficient, more economical and quicker than the hand method. The cleaning of the bottom was done with push brooms operated by hand. The ironwork of the gates and stop-plank grooves in the screen and terminal chambers was thoroughly scraped, dried by the use of torches, and painted with two coats of red lead and oil.

COST OF CLEANING WESTON AQUEDUCT

	Labor	Material	Total
Cleaning aqueduct	$270.05	$4.58	$274.63
Cleaning and painting ironwork	121.00	21.27	142.27
Repairing leaks in masonry	96.75	37.10	133.85
	$487.80	$62.95	$550.75

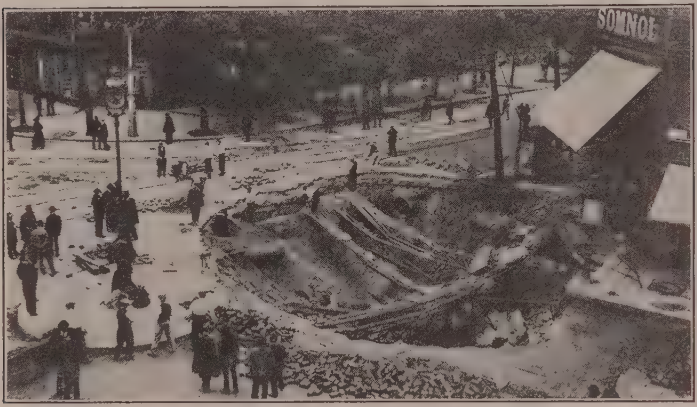
When the aqueduct was first emptied it was found that water was flowing in through small crevices in the brick and concrete, the greater number of which were between stations 659 and 671, where the aqueduct is generally in tunnel. In this section 1,400 leaks in the tunnel lining were repaired by driving and calking wedge lead, tea lead or lead wool into the joints. The cost of cleaning and repairing this section of the aqueduct is given in the accompanying table.

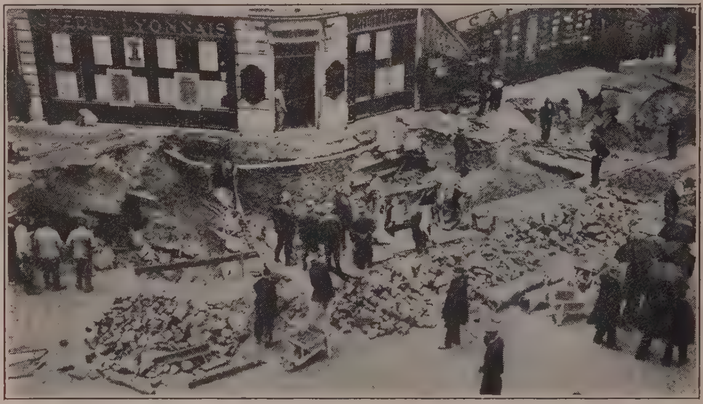
Minor repairs were made to the Cochituate aqueduct. The interior of this conduit, which was in service only 62 days during the year, was inspected, but it was not considered necessary to clean it.

Bursting Sewers Undermine Paris Streets

Heavy Rainfall Causes Overflow into Subway Excavations and Large Sections of Pavement Sink, Killing Twelve Persons

By FRANCIS P. MANN
Paris, France


DAMAGE DONE TO BOULEVARD HAUSSMANN



UNDERMINING NEAR CREDIT LYONNAIS BUILDING

HEAVY rains on June 15 and following days caused many of the streets of Paris to fall in upon the metropolitan subway tunnel work, resulting in immense holes such as never before existed in a large city under similar conditions. No less than twelve persons were swallowed up in the cavities. Although the exact causes of the accidents are not as yet clear, it seems that they were likely due to the fact that the sewers became overcharged with water from the unusual rainfall, and this caused a bursting of the sewers at some points, flooding the soil and forcing it to give way.

From the pictures it will be seen how much the soil is undermined by the subways and other city work, so that but little strength seems to be left to meet with such cases as the present. However, the accident is in no way due to an inundation of the Seine such as occurred in 1910 and backed up the river water into the sewers as far as the heart of the town. In the present case it is the heavy rains that were responsible for all the trouble in the first place, so that the two accidents are not to be compared with each other as to character.

The street actually fell in at three places, while in numerous other sections there was a sinking of the soil. The photographs show the nature of the main accidents which took place at the St. Philippe du Roule Square, Place St. Augustin and Boulevard Haussmann on June 15, these points lying along the new metropolitan subway line known as St. Cloud Gate Opera which is in construction at present. At Place St. Augustin, one of the points where vehicle traffic is most crowded, the paving fell in suddenly, swallowing up a taxicab with its passengers and driver and all perished in the lake which was formed here by the inrush of water. The length of the excavation is nearly 30 ft. at this place, and the whole of the subway vault fell in, the depth of the excavation being 30 ft. or more.

At St. Philippe du Roule a similar falling in of the soil carried away a good part of the pavement in front of the Credit Lyonnais, laying bare sewers and piping in profusion, among others the compressed-air piping. An immense excavation was formed at the corner of Boulevard Haussmann and Rue du Havre, not far from the St. Lazare railroad depot, and here will be seen a confusion of electric cables and piping. Water flowing at the bottom of the great holes made the accident more impressive, and some of the electric cables burned from short circuits, lighting up a great gas flame from broken piping, to the terror of the public. However, this display was of short duration. It took a great effort on the part of the fire brigade to recover the dead bodies, and the newspapers report that twelve persons lost their lives in the disaster. A newspaper kiosk on the street corner disappeared in the excavation, but its tenant was fortunately able to escape in time. The taxicab was found at a depth of 30 ft. No less than seventeen persons were injured.

The Minister of Public Works, M. Renoult, together with a number of official persons, made a visit to the site, and the engineers explained the conditions of constructing the subway and the way in which the sewers were taken care of during such work. Examination of the ground showed that the sewers which rested on solid soil were unharmed, while nearby was one that had burst because it was left more or less unsupported. Although the city has thousands of miles of sewers, it is seen that they stood up well under the heavy water flow except at three points where the subway was in construction. The fact that there were no less than three subway tunnels crossing at Boulevard Haussman and Rue du Havre, the place of one of the accidents, was commented on.

Above the subway tunnel at St. Philippe du Roule Square are three large sewers. At this point the infiltrations of water (due to the heavy rains) into the subway tunnel drew along the very loose soil so as to form cavities of considerable size under the sewers and the water pipes. The sewers then burst owing to lack of support and caused a general falling in of the soil and the street paving.

Numerous accidents of a minor nature due to the unusual rainfall occurred in various parts of town, such as bursting of smaller sewer piping, flooding of cellars, and the like. At Place de la Concorde there is a hole 40 ft. in diameter due to a falling in of the soil upon the work of the subway tunnel; but this accident is of less serious nature than the other. Water also entered the subway electric lines at a number of places and caused stoppage of the trains.

The debate which took place on the present question at the meeting of the Municipal Council brought out a good many contradictory views, so that the result is not of the clearest. In the present ignorance of the causes of the disaster it is hard to determine who is responsible, but the discussion is to continue at subsequent sessions, when more light may be thrown on the matter. M. Froment-Meurice states that frequently the inhabitants of the district pointed out the bad state of the pavement, that it was commencing to fall in, and such warning should not have been overlooked. Again, heavy vehicles should not have been allowed to circulate in the Rue de la Boëtie during the prosecution of the work on the subway. He proposed a motion tending to punish the engineers who may have neglected their duty in looking after the work.

M. Evain undertook to clear the City Council of all responsibility, its rôle as concerns the subway being confined to laying out the work and according the credits, both of which were satisfactorily done. All the questions regarding actual work fall upon the subway company, but as the initial cause of the accident is yet undetermined and the examination not yet completed it would seem that the discussion was premature. However, further discussion followed, in which M. Girou explained that the city sewer system was very well constructed on the whole, but the sewers depend much upon the outside pressure and no covering should be removed or sewers laid bare without putting in the needed stiffening at such places. Since the sewers had held up remarkably well, such an accident could not be foreseen, but this will be a lesson for future work. M. Oudin spoke of possible defects, such as cavities or too thin sewer conduits, and hoped there would be a strict examination made. However, it was brought out that the subway engineers had built 60 miles of line and the work had been satisfactory.

M. Pierre Baudin, a prominent engineer, gives the following opinion about the affair in the daily press: The chiefs of the municipal service, he says, are surely to be censured for their negligence in the present case, and it is impossible to admit the justification given by them—the excessive amount of rain which fell and exceeded all the provisions. Taking the case of the St. Philippe du Roule Square, the ground is there occupied by the following subsurface structures: The tunnel work of the metropolitan subway at a considerable depth, the vault of which had not been commenced, but the excavation was going on and the ground was upheld by timber work; sewers, above the subway excavation; a 6-ft. collector of the Faubourg St. Honore; the sewer which runs parallel to the collector; a gaspipe covered with concrete; an electric-light cable; a high-tension cable; compressed-air piping which runs through the sewers. A noteworthy circumstance is that these installations are made in a soil composed of fine sand which is stable as long as nothing happens to disturb it, but which flows like water when it is wet or disturbed in any way. Under this sand is a layer of moist earth which is drained off by a special drain, so that the level of the whole is likely to be changed in the course of time.

It should be noted that all the present work is concentrated in a space of 10 sq. m. and the different parts were installed one by one and at various times, which is, of course, a very bad plan. There were no efforts made to co-ordinate the work systematically so as to make up a solid ensemble which could be well strengthened.

Subway-construction methods in London are quite different from those in use in the French capital. One of the main points lies in the great depth at which the tunnels are run. At first such work was carried out near the surface, as at Paris, but later on such methods were abandoned, as is shown by the construction of the London tubes, which are from 40 to 100 ft. deep. Of course, this gives great security, and there is no danger from rain. Such tubes are built by the compressed-air system and are made of built-up steel rings.

TWO VIEWS OF CAVITY AT PLACE SAINT PHILIPPE DU ROULE, SHOWING WORK IN PROGRESS NIGHT AND DAY

STANDARD BUILDING-CONSTRUCTION SPECIFICATIONS issued by the National Fire Protection Association, Boston, are intended to establish requirements of construction suited to buildings of the greatest fire resistance. The principal items are incombustible material for all structural parts, ample space exits for all occupants, protection against exterior fires, provisions for confining interior fires to space in which it originates and installation of apparatus for extinguishing fire in its incipiency. Detailed specifications are given for service equipment, height, area, location and character of exits, allowable stresses, character of material and dimensions, construction and strength of walls, piers, columns, roofs, floors, stairs, shafts, partitions and wall openings.

Underdrain Experiences at Kansas City, Kansas

Breaking of Strainer Anchor Bolts Causes Uplift of Gravel and Rupture of Screen

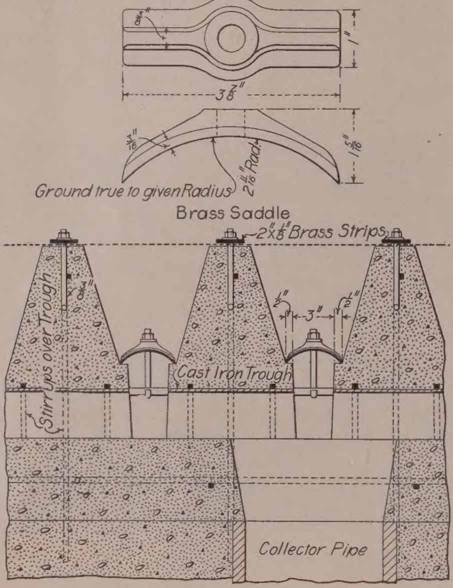
By WYNKOOP KIERSTED
Consulting Engineer, Kansas City, Mo.

FIVE of the nine mechanical filters at Kansas City, Kan., were built in 1913 and the remainder in 1911. They are all of the Cincinnati type, but experience with breaking bolts with the first installation led to minor changes in the later addition. The original strainer system consists of the usual blocks of reinforced concrete, 14 in. high from the bottom of the filter tank, spaced 12 in. center to center and so constructed as to make a battered concrete channel between the lower portion of the blocks for the lateral distribution of water and to support a screen on the top of the block to retain the gravel subdrain in place. Three transverse lines of cast-iron troughs communicate with the lateral concrete troughs. For details of the first installation see Engineering Record of Jan. 27, 1912, page 88.

Where the ends of the strainer plates butt against the concrete walls of the filter tanks a circular groove is chiseled into the concrete, into which the end of the strainer plate is anchored in a bed of cement mortar. Each of the strainer plates is bedded on a $\frac{5}{8}$-in. shoulder in mortar.

The filters were designed for velocity wash at the rate of 20 gal. per square foot per minute. It was assumed that an upward pressure of about 7 lb. per square inch would be required against the strainer plates to insure the discharge of the water at the stated rate. Evidently this washing pressure must have been exceeded, probably on account of the too rapid manipulation of the hydraulic valve on the wash pipe, for trouble was experienced by the breaking of the strainer anchor bolts, thereby causing an uplift of gravel and a rupture of the screen. These accidents became so frequent that $\frac{3}{8}$ and 7/16-in. Tobin bronze anchor bolts were substituted for the original $\frac{1}{4}$-in. strainer anchor bolts. This work, of course, necessitated the reaming out of the holes in the strainer plates and the resetting of all the plates, involving considerable expense. However, since the introduction of the heavier bolts the blowing up of the strainer plates has ceased.

In the design of the four filters recently put in a slight modification was made in the form of strainer block and a new form of strainer plate and anchorage was designed. The strainer plates are bent to the arc of a circle of 2½-in. radius, without the reverse bend at the sides of the plate. The edges of the plates are bedded in sheet lead against the shoulder formed in the concrete of the strainer block. The strainer plates in three lengths—2 ft. 8⅞ in., 3 ft. 7 15/16 in. and 3 ft. 2⅞ in.—are set in the strainer block with clearance of about 1/16 in. The anchorage of the strainer block is made by a Tobin bronze hook bolt, ⅞ in. in diameter and 6 in. long, engaging a Tobin bronze rod 9 in. long spanning the lateral channel, with ends anchored into adjoining strainer blocks. The hook bolts were secured to the strainer by nut and washer drawn tight against a ribbed red brass saddle spanning the joints in the strainer plates and bearing on sheet lead. The anchor bolts between plate joints also have a saddle bearing on sheet lead. Usually the nut and washer were packed with sheet lead, as also were the ends of strainer plates abutting against the concrete filter walls.



DETAIL OF KANSAS CITY UNDERDRAIN

The screen over the gravel is made of brass cloth of the same gage as in the old filters, but it runs transversely of the strainer blocks, instead of longitudinally, as in the earlier design. The anchorage is secured by means of a ⅜-in. Tobin-bronze bolt bedded in the strainer blocks and secured by nut and washer bearing upon a continuous strip of metal laid upon the screen along the top of each strainer block.

This late design of strainer plate and anchorage worked so well as to inspire its use in a more recent filter installation, where it is also giving good satisfaction. In this later installation no screen is used over the gravel, dependence being placed on a thick bed of gravel to support the filter sand.

ASPHALT PAVING REPAIRS in Chicago during 1913 cost 81.16 cents per square yard. There were 4,309,200 sq. yd. out of reserve at the end of the year and 3,547,600 sq. yd. were maintained at an average cost of 3.38 cents. This is the first year for the municipal asphalt plant. The repair yardage was doubled over that of the previous year, when the cost of repairs was $1.37 per square yard. Assuming fifteen years for the life of the plant and interest at 6 per cent, an addition of 6 cents per square yard should be added to the repair costs.

Book Reviews

Bulletin 3 of the State of Texas Reclamation Department is entitled "Amendments and Other Levee and Drainage Laws of Texas." This bulletin is to accompany Bulletin 2, "Levee and Drainage Laws of Texas," reviewed in the Engineering Record of April 4, 1914, page 401. Bulletin 3 deals with the duties of the engineer, questions relating to the financing and maintenance of drainage districts, petitions and elections, claims and the like. (Austin, Texas, State Reclamation Department.)

The June issue of the "Baltimore & Ohio Employees' Magazine" is an engineering number of no little interest. There are articles on various work of the company by Paul Didier, principal assistant engineer; M. A. Long, assistant to chief engineer; J. T. Wilson, district engineer; F. P. Patenall, signal engineer, and L. G. Curtis, district engineer; an abstract from an address by Earl Stimson, engineer maintenance of way; articles of interest in other lines of railroading, and sundry material of a lighter vein. The entire number is profusely illustrated.

A new geological map of the State of New Jersey, on a scale of about 4 mi. to the inch, making a map 2 x 4 ft., has been published by the Geological Survey of New Jersey, under the direction of Dr. H. B. Kümmel, State geologist. Prof. J. Volney Lewis, of Rutgers College, assisted him in the compilation. The last previous map, issued in 1888, showed twenty-four rock formations. The new one shows fifty-seven, which are indicated by eighteen different colors and various patterns of dots and lines. There have necessarily been many changes in the geological names formerly used, the addition of new ones and the correction of some errors, and the map now gives much more detailed knowledge of the State's geological history than has heretofore been available. (Trenton, New Jersey State Geologist. 50 cents.)

"Hydraulic Diagrams" is the title of a 4 x 6½-in. folder which has now appeared in its third edition and which is published by C. W. L. Alexander, M.Sc., B.E., Assoc. M. Inst. C. E., professor at University College, Cork, Ireland. The folder consists of a sheet 18 x 24 in. containing diagrams for the flow of water in water mains, sewers, open channels and rivers and over rectangular and triangular weirs. Most of the diagrams are of the logarithmic type, having straight lines only, which makes them very convenient to work with. The formulæ on which they are based are: For water mains, Hazen-Williams' formula, $V = 171\,R^{0.63}\,S^{0.54}$; for sewers, Crimp and Bruges' formula, $V = 124\,R^{0.67}\,S^{0.50}$; for open channels, Bazin's new formula, $V = k\sqrt{RS}$, drawn for the value $k = 100$, with a diagram from which the proper k can be selected and the result multiplied by $k/100$. The weir formulæ are $Q = 158.4\,H^{5/2}$ for 90-deg. triangular notches and $Q = 200\,BH^{3/2}$ for rectangular weirs. On the back of the cover there are useful hydraulic memoranda and information on resistance of bends and deterioration of water mains. The diagrams have met with approval in England and the present edition is the third since 1904. (Cork, Ireland, C. W. L. Alexander, University College. 2½ shillings, or 65 cents net, postage free.)

"Flumes and Fluming" is the title of Bulletin 87 of the U. S. Department of Agriculture, written by Eugene S. Bruce, expert lumberman of the Forest Service. Flumes are discussed from the viewpoint of the lumberman, the author explaining their use in lumbering operations and how to build them. The V-shaped wooden flume is held to be superior to the box or square-sided form, because it requires less water and, on the average, less repairs than the other type, is better adapted to act as a slide on steep grades, and offers fewer chances for jams. Concerning a third type, the "sectional" metal flume, semicircular in form, the prediction is made that it will eventually come into wide use. Such a flume is strong and light, and can be quickly taken apart and transported from one place to another to be set up again. A flume recently built on Rochat Creek near St. Joe, Idaho, is cited as a good example of modern V-shaped flume construction. This flume, which is unusually large and built to handle heavy logs and long timbers, is said to have cost approximately $8000 per mile for the 5 mi., including the cost of constructing a wagon road and telephone equipment. Other flumes are cited costing from $2000 to $7500 a mile. (Washington, U. S. Department of Agriculture.)

Dock and Harbor Engineer's Reference Book; Being a Compilation of Notes on Various Matters Connected with Maritime Engineering and Ports and Harbors. By Brysson Cunningham, B. E., Assoc. M. Inst., C. E., Author of "Dock Engineering," "Harbor Engineering," etc.; 319 pages; 144 illustrations, including 6 folding diagrams. Philadelphia, J. B. Lippincott Company, $3 net. (Reviewed by E. P. Goodrich, Consulting Engineer, New York City.)

Few books have such a comprehensive description for a title page. Were one to add two facts—viz., that the book is of the convenient handbook size and contains 319 pages on practically every subject included within the scope of the title—the technical description would be complete. Naturally the book treats of English and Continental matters and methods, although American practice is exemplified in quotations descriptive of some concrete work in this country, and of American dipper-dredges, together with information about the principal lake harbors of North America. More than 300 exceedingly pertinent quotations concerning specific structures, methods or phenomena are included in the eight sections into which the book is divided. A fairly satisfactory index completes the work. Many quotations are derived from the proceedings of the Institution of Civil Engineers, while a number of others are taken from the proceedings of the International Navigation Congresses. The diagrams are from the latter source and have particular reference to the dimensions of vessels built since 1830. The book is considered exceptionally worthy of praise, being specially commended to all interested in dock and harbor work in all of their branches.

WATER-POWER DEVELOPMENTS in California to the total construction cost of $5,941,300 have been sanctioned by the State water commission, according to a recently issued report, during the two years ended April 1, 1914. Since Jan. 1, 1913, twenty-one out of thirty-eight applications to appropriate water have been rejected, according to the report, either for failure to comply with rules prescribed by the commission or on the ground that the interests of the State demanded such rejection.

Letters to the Editor

Cost of Preparing New York City Contracts

SIR: The letter by B. M. Wagner in the issue of June 20, page 713, again brings up the matter of "standardized specifications" for public work and emphasizes the fact that this seems to be a much simpler matter than it really is. It is true that on a paving or similar contract, involving only a few items, printed standard specifications can readily be used, but on large public buildings, involving a hundred or more different items, the attempt to use such specifications involves endless confusion unless a great amount of care is used in selecting and combining the proper parts of the standards into the specifications for each particular contract.

The system formerly in use in the New York State architect's office illustrates this condition very well. Under the law the State architect was required to prepare printed standard specifications for every item likely to be used in State buildings. When the specifications for a building were made up, the printed pages covering the different items entering into the construction were bound together, and then, to make them fit the particular job, a mimeographed set of "amendments" was attached to the whole thing, some of the amendments entirely destroying the paragraphs which they amended. The specifications for a $25,000 job under this system made a book about 8 x 9 in. and nearly an inch thick, and then, on close examination, it would generally be found that several items shown on the plans were not specified either in the text or the amendments. The general conditions, of course, stated that unless amended the printed portions remained in force, but the writer remembers that on contracts which he had charge of the task of explaining to foremen and subcontractors just what the specifications meant was an almost endless one.

It is very proper, I think, to have established standards of quality, but to take a book of printed specifications and make them fit every job without revision and rewording is only to leave openings for misunderstandings, disputes and litigations.

CHAS. I. DINGMAN,
Engineer, Flynt Building & Construction Company.
Palmer, Mass.

Vents on Steel Pipe Lines

SIR: I have carefully read the article of M. L. Enger and F. B. Seely on "Vents on Steel Pipe Lines," which appeared in Engineering Record of May 23, page 594, and believe that this paper contains most valuable information to designers of waterworks or hydroelectric plants.

I would like to comment upon the discrepancy the writers show to exist between the theoretical and experimental value of the critical external pressure. Formula (1) as derived in the paper, by applying Euler's formula for columns with free ends, can be considered as a very rough approximation only. As a matter of fact, by more elaborate methods the correct value of the critical normal pressure on a thin pipe is given as

$$p_2 - p_1 = p = 3\,E\,I/r^3$$

or in terms of the thickness of the shell and the diameter

$$p = 2\,(t/d)^3\,E$$

Substituting a value of 29,000,000 lb. per square inch for E, the value of the critical external pressure reduces to

$$p = 58{,}000{,}000\ (t/d)^3$$

It may be seen, as compared with equation (3) of the paper, that the theoretical critical pressure agrees very closely with the experimental value. The theoretical value is naturally the greater of the two, it being impossible to attain mathematical exactness in practice.

EUGENE E. HALMOS.

New York City.

[This letter was submitted to the authors of the article, whose reply follows.—EDITOR.]

SIR: In Love's "Mathematical Theory of Elasticity" the collapsing pressure for a long cylindrical thin pipe is given in our notation as:

$$p_2 - p_1 = p = \frac{2E}{1 - n^2}\left(\frac{t}{d}\right)^3$$

where n is Poisson's ratio. Using the ordinary value of $n = 1/3$ for steel, the equation becomes

$$p = 2.25\,E\ (t/d)^3$$

If n is neglected, $p = 2\,E\ (t/d)^3$ the one suggested by Mr. Halmos, which was first derived by G. H. Bryan.

It will be seen that the forms of the equations are the same, namely

$$p = k\ (t/d)^3$$

where k is 2, 2.25, or 2.67 according to the method of derivation. As it was the purpose of the writers to show that the empirical formula $p = 50{,}200{,}000\ (t/d)^3$ had a rational basis and could therefore be used for pipes of larger diameter than those experimented upon, it was thought that the application of Euler's well-known formula would be the most acceptable to engineers.

M. L. ENGER.
F. B. SEELY.

Urbana, Ill.

Panama Canal Tolls

SIR: Now that Congress has determined that coastwise shipping is to pay the same tolls through the Panama Canal as ships engaged in commerce with or between other countries, the question may be again considered as to whether all tolls authorized in the toll act are not too high. In this connection the writer addressed a communication last month to Senator Perkins of California as follows:

"In a telegram to Maj. F. C. Boggs for the information of Senator Simmons, under date of April 24, Gen. G. W. Goethals, Governor of the Canal Zone, in stating the amount necessary to be raised by canal toll says:

"'I believe tolls should pay outstanding indebtedness, fixed charges and operating expenses, leaving amounts appropriated from current revenues to be contribution of present generation toward canal, and because of unknown future condition not burdening posterity for remainder.

"'Bond issues to date under canal acts, $134,651,980; interest on these, approximately, $3,200,000; annual amount to be set aside for redemption of bonds, $3,250,000; operating and maintenance, $5,250,000; annual payment to Panama, $250,000. Amount to be secured annually through tolls is, therefore, $11,950,000. If additional bonds are issued these figures should be changed accordingly.'

"There is here included $3,250,000 per annum for redemption of bonds. If the inclusion of this amount is proper and commerce is to be charged with the cost of the construction of 36 per cent of the canal, why should not the entire cost of the canal, or about $375,000,000 at an annual rate of $3,750,000, as suggested by Prof. E. R. Johnson, be charged to shipping and be repaid to the United States by those who are using the canal?

"The canal has been constructed and has been paid for by the United States and the United States should not now plan to recover its cost from those who desire to use it. If the United States collects, as contemplated by Professor Johnson, interest on its entire investment, or, as suggested by Governor Goethals, interest on part of its investment, then the canal may be regarded, in whole or in part, as a revenue (interest) producing investment, and the United States will stand practically in the position of having loaned the money that was necessary to make the enterprise feasible. The Nation may not then be in a position to claim the distinction of having made a large financial contribution for the benefit of the world's commerce.

"If the earnings of the canal are so regulated that they will amortize the cost of the canal and will also cover interest on this cost, these earnings will have to be greater by some $15,000,000 per annum, according to Professor Johnson's figures, than if operating expenses alone were to be covered. Moreover, when after 40 or 100 years bonds have been redeemed and the repayment to the United States of the cost of the canal is complete, the vastly increased traffic through the canal will have only the operating expenses to meet, unless, indeed, the canal is to be operated for profit.

"Any program which thus involves higher earnings in the earlier years of the canal's life than later is undesirable and unfair to the commerce of our own time. There should be no hesitation in benefiting those of our own day, who are waiting to use the canal, by putting no greater burden upon the shipping than may be necessary to meet the operating expenses, including, of course, the depreciation of perishable parts of the canal and the annual payment to Panama. The investment in the canal might well be treated the same as practically all other Government investments in improvements for general benefit. There would then be no provision for redemption of capital, nor would any interest be collected. If interest is collected there will have been no real contribution at all in aid of commerce, but the United States will have made, as stated, a revenue-producing investment, and this in the case of the Panama Canal was hardly what this country intended. If both amortization and interest are collected from those who use the canal, this will be an indirect way of assessing a part of the cost of the canal on the outsiders who use it—a situation which when fully understood will be disavowed by this nation, particularly when, as will be generally admitted, the canal is worth for military purposes alone all that it has cost.

"The canal tolls should not, therefore, be fixed with a view to have the annual earnings include $3,250,000 to redeem $134,651,980 of bonds, as suggested by Governor Goethals, nor $3,750,000 to ultimately reimburse the United States for its outlay of

$375,000,000, as suggested by and included in the estimates of Prof. E. R. Johnson; nor in fact, any other amount for amortization. The earnings, furthermore, should be estimated to include interest only on such part of the cost of the canal as the United States desires to have considered as a loan to commercial interests and not as a donation. This amount should be nothing at all, or only a small portion of the total cost of the canal.

"I repeat, there should be no redemption of bonds nor any repayment of the cost of the canal out of the canal earnings; nor should the canal earnings cover any interest on this investment, if the United States is going to make its full investment in the canal a real financial contribution for the benefit of commerce."

Any canal tolls now established will yield a gradually increasing revenue, because there is no question concerning the growth of traffic through the canal. Is it wise, under such circumstances, to make the canal in its early years earn even as much as operating expenses? It would be not at all unreasonable to exclude from the required earnings, for a time at least, the element of depreciation. If this is done, then after a number of years, when it may be assumed that traffic can bear the burden, there will be accrued depreciation to be cared for.

The adoption of the following principles is, therefore, urged in order that the canal may be, as it is intended to be by this nation, of greatest possible benefit to commerce with incident greatest possible benefit to all sections of our own country:

First. The investment has been made for the benefit of commerce, and for military advantages, without intention to recover the cost of the canal from those who use the same, either by traveling or by shipping their wares through it.

Second. The entire cost of the canal is to be regarded as an investment by the United States for military purposes, and as an aid to the commerce of the world, and not as an investment for profit.

Third. The canal tolls should be fixed with a view of providing at the outset adequate canal operating expenses, including the upkeep of all parts thereof, and the replacement of perishable parts from time to time as these parts wear out or become inadequate and have to be replaced, including also the annual payment of $250,000 to the Republic of Panama.

Fourth. After a time, when the volume of commerce justifies such a course, the net earnings should also cover interest on a part of the cost of the canal, increasing with the growth of commerce until possibly interest on its full cost is reached.

The adoption of these principles would be a wise and in every way sound policy. It may not be unreasonable to assume that they will, when understood, be concurred in by the American people. The objection that will be urged to them is the fundamental one that those who use the canal, whether of this country or foreigners, should contribute through the medium of tolls toward the cost of the canal.

When jetties were constructed at the mouth of the Mississippi River for the improvement of the river entrance, or when the breakwater was constructed at San Pedro for the improvement of Los Angeles harbor, or when Ambrose Channel was constructed for access to the harbor of New York there was no thought of a charge upon shipping to recover the cost of these works or interest on this cost. They are in service as a benefit to all alike who would use them. It is true that the use of such improvements by foreign shipping implies commercial relations with the United States. In the case of the Panama Canal there would be ships passing through engaged in commerce that is in no wise connected with this country. The question may well be asked to what extent this fact should, if at all, modify the general policy heretofore adopted of making no interest or redemption charge on the cost of Government works in aid of commerce, and the answer to this question would be the guide in applying the fourth principle as above set forth.

C. E. GRUNSKY,
President, American Engineering Corporation.
San Francisco.

Excavation Done by U. S. Reclamation Service

SIR: The accompanying diagram, compiled from official records of the U. S. Reclamation Service and from data in the "Canal Record" and the "Barge Canal Bulletin," affords an interesting comparison in the amount of excavation done by the Reclamation Service, that done in Culebra cut under American direction, and that done on the New York State Barge Canal.

Reclamation Service.—The act under which the Reclamation Service was established was approved by President Roosevelt June 17, 1902, and actual construction was commenced on the Salt River project in Arizona the following year. On Dec. 31, 1913, the total excavation involved in the construction of the 8325 mi. of canals and ditches of the various projects and of the structures, dams, etc., amounted to 106,260,250 cu. yd.

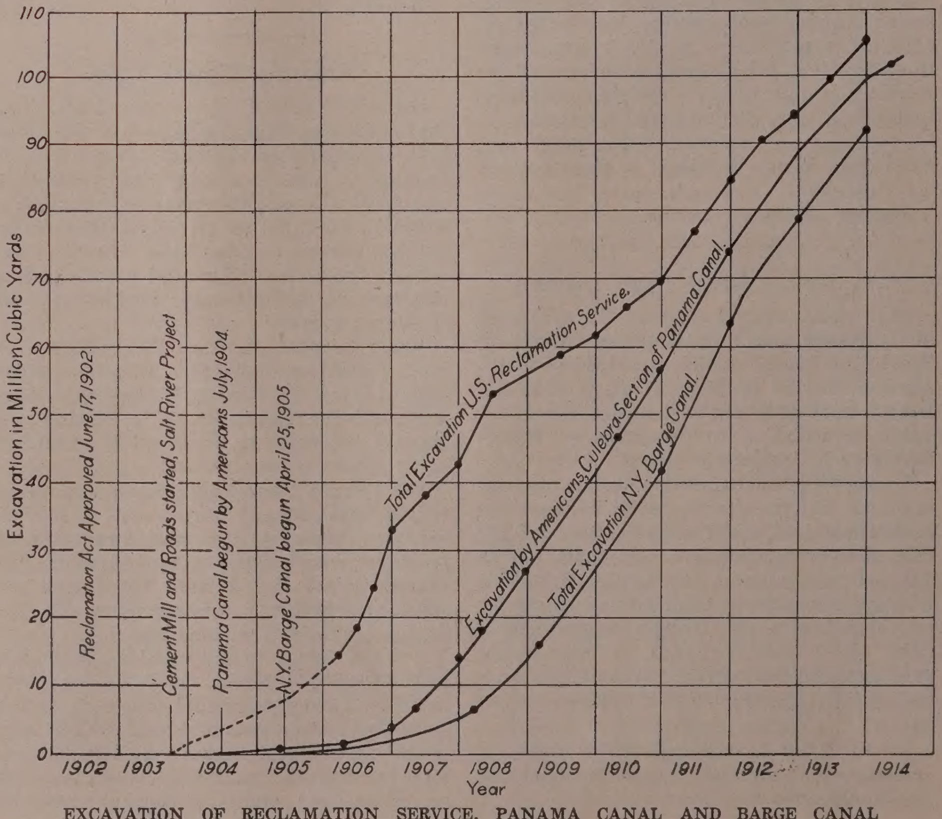
Panama Canal.—On May 4, 1904, the transfer of the Panama Canal property from the French company to the United States took place and work on excavation in Culebra division, which was in progress, was continued, work in Culebra cut proper commencing in July, 1904. On Dec. 31, 1913, the total excavation by the Americans in the Culebra section, which is practically identical with Culebra cut, was 98,750,966 cu. yd., and on April 30, 1914, 101,476,661 cu. yd. The total excavation by the Americans on April 30 amounted to 220,825,562 cu. yd., which included more than 86,000,000 cu. yd. of wet excavation or dredging.

New York State Barge Canal.—In December, 1904, the first bids were opened for construction work on the New York State Barge Canal, and the first actual construction work was begun on April 25, 1905. On Dec. 31, 1913, the total excavation under the 123 construction contracts completed or in force amounted to 92,021,976 cu. yd.

Excavation Diagram. — The diagram shows the progress on these three engineering projects from the time of commencement of the work, or, in the case of the Panama Canal, from the date of taking it over by the Americans, for the work on the Culebra section only. It will be noted that the progress on the Culebra section and on the Barge Canal is fairly uniform and regular, while the progress on the work of the Reclamation Service is more irregular, due in part to the variation in the character of the work on the various projects and in part to the lack of money for carrying on the work as rapidly in the later years as was done in the years 1906, 1907 and 1908.

W. I. SWANTON,
Assistant Engineer, U. S. Reclamation Service.
Washington, D. C.

CLEANING SEWERS and catchbasins in Chicago in 1913 cost $287,378 for the 4,820,000 ft. flushed, 390,000 ft. scraped and 39,738 catchbasins cleaned. About 23,500,000,000 gal. of sewage were pumped at five stations at a cost $71,450.



EXCAVATION OF RECLAMATION SERVICE, PANAMA CANAL AND BARGE CANAL